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ABSTRACT

This research study investigated the effects of tutoring by trained paraprofessionals on pupil outcomes in the areas of mathematics achievement, self-concept as related to mathematics, attitude toward mathematics, and external locus of control as related to mathematics. It also sought to investigate the relationship between certain tutoring skills and pupil outcomes in those areas and to study whether the effects of mathematics tutoring were associated with the initial ability level of pupils in those areas. Five achievement tests and attitude scales, measuring 15 variables, were administered to approximately 320 fourth- and fifth-grade pupils in nine schools. Data collection, training, and experimentation extended over a period of four months. The study failed to demonstrate that mathematics achievement and attitudes could be increased as a result of tutoring or training in tutorial skills. (MP)

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MATH TUTORING STUDY

STUDY II:

PARAPROFESSIONALS AS TUTORS

Barbara I. Williams
Henry A. Banks
Beatrice A. Ward
David C. Berliner
Leonard S. Cahen

REPORT A77-1

Far West Laboratory for Educational Research and Development

1855 FOLSOM STREET • SAN FRANCISCO, CALIFORNIA 94103 •

SE 027 957

FAR WEST LABORATORY
FOR EDUCATIONAL RESEARCH AND DEVELOPMENT

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Barbara I. Williams
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Beatrice A. Ward
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With special advice and assistance from

Robert Linn
Charles Dunbar

January 1977

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The Math Tutoring Study: Paraprofessionals as Tutors represents an ambitious, large scale attempt to determine the effects of tutoring on mathematics achievement and pupil attitudes. Teachers and principals from 9 schools in the San Francisco Unified School District agreed to participate in the study. Five achievement tests and attitude scales, measuring 15 variables, were administered to approximately 320 pupils. Data collection, training, and experimentation extended over a period of four months.

This type of large-scale field based research requires the cooperation and talents of many people whom we wish to acknowledge here. First, we express our appreciation to the administrative staff of the San Francisco Unified School District. The staff of the school district's paraprofessional office provided us with important support and assistance as did the research and curriculum staffs. Thanks are also given to the principals, teachers and their pupils who gave excellent cooperation in all phases of the project.

We are particularly indebted to the 31 paraprofessionals who worked with us throughout the study and to the 18 additional paraprofessionals who began the study but were unable to continue when the data collection period was extended beyond the original timeline. Without these individuals, the research would not have been conducted.

The research design was conceptualized through the collaborative efforts of the senior author; the Math Tutoring team consisting of Henry Banks, Cassandra Coleman, Jacomina Newman, Deborah Walton, and Lynn Whitmore; with major input on researchable variables from David Berliner and Beatrice Ward. The design was considerably improved by the consultation of

Robert Linn of the University of Illinois at Urbana and Leonard Cahen. Others who reviewed and contributed to the design were Stephen Klein of the University of California at Los Angeles, Leonard Marascuilo of the University of California at Berkeley, Barak Rosenshine of the University of Illinois, James Shaver of Utah State University, and Samuel Messick of Educational Testing Service.

Coordination of the various phases of the study was done by members of the Math Tutoring Team. Henry Banks was primarily responsible for coordinating the tutorial training. Jacomina Newman was responsible for developing the training materials for observers, in addition to recruiting, training, and supervising them. All members of the team participated in pre and post testing of pupils. A special acknowledgement must go to the observers who collected information on the use of tutor skills in the tutorial setting.

The data analysis phase of the study was directed by Leonard Cahen and the senior author. Fannie Walton was responsible for data management. The computer work used to generate many of the analyses of data was done by Patricia Alker and Charles Dunbar. In addition, statistical consultation and the regression analyses were performed by Robert Linn.

The writing of the final report is primarily the work of the senior author, Beatrice Ward, and Robert Linn. Editorial assistance was provided by Mary Dawson and Marion Lentz who also performed as major proofreader. The draft of the report was typed by Deborah Walton who also designed and organized the production of all materials that were used in the study. This final report, including all graphics, was prepared by Carolyn Amable.

The Math Tutoring Team is particularly indebted to Deborah and Carolyn for their exceptional organizational abilities.

Barbara I. Williams
January, 1977

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ABSTRACT

The Math Tutoring Study II: Paraprofessionals as Tutors investigated the effects of tutoring by trained paraprofessionals on pupil outcomes in the areas of mathematics achievement, self-concept as related to mathematics, attitude toward mathematics, and external locus of control as related to mathematics. It also sought to investigate the relationship between certain tutoring skills and pupil outcomes in those areas and to study whether the effects of mathematics tutoring were associated with the initial ability level of pupils in those areas.

Four research questions were asked:

1. Are there differential effects from systematic mathematics tutoring associated with the initial ability level of tutored pupils on a set of dependent variables?

2. Do pupils who receive systematic mathematics tutoring from tutors trained in tutorial skills perform better on a set of dependent variables than pupils of comparable ability who receive systematic mathematics tutoring from tutors who have not had mathematics tutoring training?

3. Do pupils who receive systematic mathematics tutoring perform better on a set of dependent variables than pupils of comparable ability who receive no systematic mathematics tutoring?

4. Are there particular combinations of tutoring skills or interpersonal behaviors which are positively related to specific pupil outcomes?

In order to answer these questions, three treatment conditions were specified:

1. Minicourse 5 and mathematics trained tutors, in which paraprofessional tutors received training in certain specified tutoring skills through Minicourse 5 (see Appendix A) and training in specific mathematics skills and concepts and then tutored each of six pupils individually in four fifteen-minute sessions per week for nine weeks.

2. Mathematics only trained tutors, in which paraprofessional tutors received training only in specific mathematics skills and concepts and then tutored each of six pupils individually in four fifteen-minute sessions per week for nine weeks.

3. Control treatment to which no paraprofessional tutors were assigned.

Pupils in both tutoring treatment conditions continued to receive regular mathematics instruction from their classroom teachers along with their classmates. The tutoring sessions, held at the same time each day in a spare room of the school, were scheduled so that pupils were not absent from regular mathematics instruction in their classrooms.

The control group consisted of pupils who did not receive regular, consistent tutoring by paraprofessionals but instead participated only in ongoing classroom activities in common with the pupils in both treatment conditions. The pupils selected for the control group were pre and post tested at the same time as tutored pupils.

Paraprofessionals were recruited and employed by the Far West Laboratory for Educational Research and Development.

Tutors were stratified by sex and then randomly assigned to treatment conditions, approximately one-half of each sex to receive training in both mathematics skills and Minicourse 5 tutoring skills and one-half to receive mathematics training only. The tutors assigned to each treatment condition then were separately assigned at random to the nine participating schools, ensuring that tutors in both treatment conditions were assigned to each school and that at least one male and one female tutor were assigned to each. The number of tutors assigned to each school varied, depending upon the number of tutors the principal had decided could be accommodated in the particular school.

The student sample for the study was comprised of fourth and fifth grade pupils in the nine schools: (1) whose teachers had agreed to permit their pupils to participate, (2) who were not classified by the school either as being gifted or as having learning disabilities, and (3) who were fluent in English. This population first was stratified by grade and sex and then pupils within each stratum were randomly selected for participation.

The selected pupils were pretested from October 29 to November 9, 1973, using the following instruments:

1. The Modern Mathematics Supplement to the Iowa Tests of Basic Skills (ITBS)
2. The computation section of the Comprehensive Tests of Basic Skills (CTBS), Level 2
3. The Dutton-Likert Attitude Toward Mathematics Scale (ATMS) and a locus of control instrument called Feelings About Math
4. The Modified Sears Self-Concept Inventory, which for purposes of this study was called About Myself (AbMy) and contained an Academic Self-Concept and a Math Self-Concept scale.

Two-thirds of the participating pupils within each of the schools--stratified by grade level, sex, and above/below median CTBS achievement--were then randomly selected to receive mathematics tutoring. The participating pupils not selected for tutoring were considered to be inschool controls.

The pupils within each of the nine schools who had been selected for tutoring were randomly assigned to paraprofessionals. The paraprofessionals, in turn, had been randomly assigned to schools and treatment conditions, as described previously.

Each paraprofessional tutor was assigned six pupils. Assignments were made without regard to the pupils' classroom assignments--that is, without any attempt to insure that the pupils were drawn from different or the same classrooms. In effect, however, it was rare for any tutor to be assigned more than three pupils from a single class.

Of the six pupils assigned to each tutor, three had scored above and three below the grade level median for their school on the CTBS. In each case, the six pupils were evenly divided between fourth and fifth graders, and at least one pupil of each sex was included.

The study was originally planned for a nine week duration, from the week of February 18 through the week of April 22, 1974. Tutoring began as scheduled. However, it was interrupted after three weeks by a strike of the employees of the City of San Francisco. Following the end of the strike, a special retraining session was held for the paraprofessionals on March 29. Tutoring resumed on April 1 and continued for six weeks until May 17, 1974. Questions regarding the impact of this interruption were considered in interpreting the results.

During the tutoring, the paraprofessionals kept logs indicating the areas in which pupils were tutored and the amount of time devoted to tutoring. Paraprofessionals and pupils were observed in the tutorial setting so that use of tutoring skills and interpersonal behaviors could be studied.

The results of the study may be summarized as follows:

1. Pupil outcomes in mathematics achievement and in affective areas based upon participation or non-participation were generally not related to pupils' initial status on the dependent variables.

2. Training in tutorial skills was found to have no significant effect upon pupil outcomes in mathematics achievement or upon attitudes when pupils tutored by trained and untrained tutors were compared.

3. Differences in mathematics achievement and in the affective areas were found to be nonsignificant when tutored pupils were compared with a control group of pupils who did not receive tutoring from paraprofessional tutors, although trends in favor of tutored pupils were evident.

4. The communality regression analyses demonstrated that the cluster of variables which contained the pupil pretest scores accounted for the greatest amount of variance in pupils' adjusted post-scores. However, the cluster which contained the interpersonal behaviors of tutors provided a small but unique contribution for nine of the twelve dependent variables, and the cluster which contained the skills emphasized in Minicourse 5: Individualizing Instruction in Mathematics provided a small but unique contribution to variance in two of the twelve dependent variables. Overall, a relationship between tutoring skills and interpersonal behaviors of tutors to pupil outcomes was not strongly demonstrated.

Given the results of this study, questions must certainly be raised concerning the quantity and quality of the treatment that was present. Over the nine week duration of the study, pupils were tutored for an average of 50 minutes per week. In the majority of the studies reported

in the literature which show positive growth in mathematics achievement and/or attitudes towards mathematics as a result of tutoring, tutoring was scheduled for a minimum of 60 minutes per week (see Van Mondfrans, 1968; Rogers, 1969; Schoeller and Pearson, 1970; Bausell, Moody, and Walzl, 1972; and Solomon and Achenback, 1974). It is entirely possible that the treatment in this study was not strong enough to positively influence mathematics achievement and attitudes.

A more difficult question to address is concerned with the quality of the treatment. The tutoring skills upon which the Minicourse is based are those skills emphasized in the mathematics remediation literature. The results from this study document the fact that these skills are used by adults in the tutorial setting, whether or not they receive tutorial training (see Table 14 page 61). The study further indicates that there is little relationship between usage of the tutorial skills emphasized in Minicourse 5 and positive pupil outcomes in mathematics achievement and attitudes. The methodology employed in the present study does not allow exploration of the quality of treatment, although this is an area which should be studied in research on teaching. It is possible that skills should be studied in combination, rather than singly, and that attention should be given to appropriateness of skill usage.

In conclusion, whether because of an insufficient treatment in terms of time spent in tutoring, because of the specific skills and affective behaviors which were chosen for study, because of the more stringent experimental controls in this study, or because of the intervention of the strike, this study failed to demonstrate that mathematics achievement

and attitudes could be increased as a result of tutoring or training in tutorial skills. As these results conflict with those found in most mathematics literature, replication of this study is recommended.

SECTION ONE

BACKGROUND

CHAPTER I

PURPOSES

The Math Tutoring Study was comprised of three separate research efforts investigating the effects of tutoring upon students in the fourth and fifth grades. The tutors in these three studies were alternatively regular classroom teachers, paraprofessionals, and other pupils. Study II, Paraprofessionals as Tutors, is reported in this volume.

This chapter presents the purposes of the study within the broader framework of research on teaching at the Far West Laboratory and states the specific research questions to which the study was addressed.

Effective Teacher Education Program

The Math Tutoring Study: Paraprofessionals as Tutors was conducted as part of the Effective Teacher Education Program (ETEP), a program of research and development in teaching at the Far West Laboratory sponsored by the National Institute of Education. During the period from 1973 through 1975, ETEP research was devoted to two major purposes: (1) to study the effects upon student outcomes of specific teaching skills and (2) to test various approaches to the study of teaching. The Math Tutoring Study is one of several programmatic efforts consistent with these objectives that have grown out of the Laboratory's earlier work in the field of teaching.

In 1966, the Laboratory's Teacher Education Program received federal funding to develop a series of skill training packages for teachers called Minicourses (Borg, Kelley, Langer, and Gall, 1970). Research evidence accumulated in the development and testing of these Minicourses shows they

are effective in bringing about desirable changes in teachers' classroom behavior. A small number of research studies (Hofmeister and Stowitschek, 1974; Strickler, 1972; and Ward, 1971) also have examined how the changes in teacher behavior brought about by Minicourse training subsequently affect student learning. Yet, we know relatively little about whether students of Minicourse trained teachers learn more than students of teachers who have not received Minicourse training.

In response to this issue, the Effective Teacher Education Program undertook an ambitious multi-year program of research on teaching effectiveness. Focusing for the most part on teaching skills contained in one or more of the Minicourses developed during the initial seven years of work, the 1973-75 ETEP research investigated the effect of their use on student outcomes. Three aspects of teaching were investigated:

- Use of mathematics tutoring skills. The study reported here is one of three that were conducted, each employing a different individual in the tutorial role. As will be discussed in greater detail in this report, the tutoring skills studied were largely drawn from Minicourse 5, Individualizing Instruction in Mathematics.

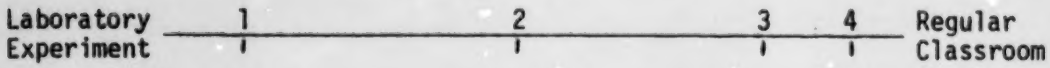
- Use of questioning skills. Two studies were conducted. Both investigated the effects on student achievement and attitudes of teacher use of questioning skills drawn from Minicourse 1 , Effective Questoning--Elementary Level, and Minicourse 9, Higher Cognitive Questioning.

- Use of an independent learning system. The purpose of this study was to investigate the effect upon students of an independent learning system. Training in the implementation and use of the system was provided by Minicourse 15, Organizing Independent Learning--Intermediate Level.

In addition to studying the effects on students of teacher use of these sets of skills, ETEP research has explored four approaches to the study of teaching. As illustrated in Figure 1, these approaches fall along a continuum of research techniques that range from a tightly controlled laboratory experiment to work in the regular classroom where instructional and other variables are allowed to vary naturally.

FIGURE 1

Continuum of Approaches to the Study of Teaching



1--Semi-programmed approach
2--Experimental Teaching Unit
3--Train teacher; study specific skills in specified instructional setting
4--Train teacher; establish instructional system; study overall effect.

The semi-programmed approach was used in the ETEP questioning studies. In this approach, the teacher is provided with a set of curricular materials which are to be used in a specified sequence and at stated times. In the questioning studies, teachers were given a script detailing the content and sequence of questions to ask in discussion. This approach was only "semi" programmed because some teacher behaviors during discussion were contingent upon student responses.

The second approach, the Experimental Teaching Unit (ETU), was incorporated as a sub-study of the mathematics tutoring study with teachers as tutors. An ETU consists of a statement of teaching and learning objectives, curricular materials for students, and criterion referenced pre and post tests. Teachers are allowed to organize and teach the unit as they wish. This approach, therefore, controls the content but not the process of instruction.

The third approach was employed in the Math Tutoring Study reported here. In this instance, paraprofessionals were trained to use a particular set of skills and then the effects were studied when the skills were applied in a content area that is ongoing in the school setting. This is a familiar

form of research on teaching which has been used in a large number of the existing studies on teaching.

The fourth approach to the study of teaching in ETEP research parallels the procedures applied in many previous studies of innovative educational programs. Teachers are trained in a new educational program; the program is put into operation; the effects on students are studied. This approach was used in the ETEP Independent Learning Study.

Thus, within the larger perspective of ETEP, the Math Tutoring Study was one of several studies designed to investigate effects on student outcomes of specific teaching skills and to test varied approaches to the study of teaching.

Research Questions

The Math Tutoring Study: Paraprofessionals as Tutors investigated the effects of tutoring by paraprofessional classroom aides on pupil outcomes in the areas of mathematics achievement, self-concept as related to mathematics, attitude toward mathematics, and external locus of control as related to mathematics. It also sought to investigate the relationship between certain tutoring skills and positive pupil outcomes in those areas.

Four specific research questions were asked:

1. Are there differential effects from systematic mathematics tutoring associated with the initial ability level of tutored pupils on a set of dependent variables?

2. Do pupils who receive systematic mathematics tutoring from tutors trained in tutorial skills perform better on a set of dependent variables than pupils of comparable ability who receive systematic mathematics tutoring from tutors who have not had mathematics tutoring training?

3. Do pupils who receive systematic mathematics tutoring perform better on a set of dependent variables than pupils of comparable ability who receive no systematic mathematics tutoring?

4. Are there particular combinations of tutoring skills or interpersonal behaviors which are positively related to specific pupil outcomes?

CHAPTER II

REVIEW OF THE LITERATURE

The literature contains numerous reports of the use of tutoring as an instructional technique and details a wide variety of tutoring approaches. In this review, representative studies are summarized in three major sections: (1) teaching skills associated with effective tutoring, (2) tutoring and achievement, and (3) tutoring and affective outcomes.

Teaching Skills Associated with Tutoring

Researchers generally are in agreement about the specific teaching skills necessary for effective tutoring. First, the importance of diagnosis as a preliminary procedure is stressed (Dougherty, 1962). As Brueckner and Bond (1955) state: "Diagnosis must precede treatment. Treatment must be based on a diagnosis." Diagnosis usually involves administering a standardized or informal diagnostic test and analyzing student performance as a basis for planning a specific tutoring program to eliminate content deficiencies.

A second important tutoring skill emphasized in the literature is the use of various demonstration techniques (Brueckner & Bond, 1955; Ross, 1963; and Unkel, 1971). The value of using such demonstration techniques as manipulatives, number lines, and estimation can be linked to the developmental theories of Bruner and Piaget (Bruner, 1966; Ginsburg and Opper, 1969) which support the view that children need concrete experiences in order to add new ideas to their cognitive structure. For example, hands-on experiences with manipulative materials may help to make abstract mathematical concepts more meaningful to students (Fennema, 1973).

In a study in which preservice teachers used manipulatives to tutor elementary students in mathematics, Unkel (1971) found that both the teachers and the students made significant gains in mathematics achievement. The primary teaching strategy was the use of task cards and manipulatives, with the students receiving tutoring for one to two hours a week for an academic year. At the end of the year, students showed a significant gain in arithmetic reasoning, fundamentals, and arithmetic totals. The preservice teachers made a significant gain in their own mathematics skills as well.

Praise for correct responses is a third important tutoring skill identified in the literature. One of the core elements in the study of programmed tutoring made by Ellson, et al (1968) was the frequent and immediate reinforcement of correct student responses. Ellson's approach emphasized student success. Tutors were instructed not to comment on student errors and instead provide reinforcement for each correct student response. Students who were tutored in two daily fifteen-minute programmed sessions showed a significant gain over their corresponding controls at mid-year and post testing in a battery of reading and language measures.

Davis (1972) trained sixth graders to use praise and tokens to reward their third grade tutees for correct work in a Science Research Associates instructional program. He found that correct student responses increased when they were reinforced. In a similar study, Johnson and Bailey (1972) trained fifth graders to tutor kindergarten students in simple mathematics tasks. Tutors were instructed to praise correct responses in a consistent manner. After twenty-six weeks of tutoring, tutored pupils had made a significant gain over control pupils in

mathematics achievement. Moreover, observation and achievement data for each tutor/tutee pair showed that the tutors who reinforced the least had tutees who evidenced the least gain in achievement.

In addition to the foregoing three skills--diagnosis, use of demonstration techniques, and praise--researchers mention a number of other effective tutor skills: giving students practice on specific areas of difficulty (Dougherty, 1962; Harvey and Kyte, 1965; and Glennon and Callahan, 1968); breaking up learning steps into small units (Ross, 1963; Ellson, 1968); giving students feedback about the correctness of their responses (Ross, 1963; Frager and Stern, 1970); locating and reinforcing tutee interests (Dillner, 1971); and interacting with students during the tutorial sessions (Harris, 1972). While these additional skills have not been investigated thoroughly, preliminary data suggest they may be significant variables in the tutoring process.

The tutor training vehicle used in this study, Minicourse 5: Individualizing Instruction in Mathematics, provides training in the three major teaching skills identified by researchers as important in tutoring--diagnosis, use of demonstration techniques, and praise--and in several other skills. (For a description, see Appendix A.)

Tutoring and Achievement

While educational literature contains many descriptions of tutoring programs, it provides few examples of systematic and empirical investigation of the effects of tutoring. In general, studies of tutoring have demonstrated that mathematics achievement can be increased (see Schoeller, 1970; Van Mondfrans, 1968; Rogers, 1969; Parres and Hoops, 1972; and

Salomon and Achenbach, 1974). In most of those studies tutor training procedures were not specifically identified, no stated criteria were used for the selection of pupils to be tutored, and in many cases the number of pupils in the study was small. Two studies of particular relevance to the present study are reviewed below. (For a complete review of tutoring studies related to achievement prior to 1969, see Rosenshine and Furst [1969].)

Bausell, Moody, and Walzl (1972) investigated the effects of tutoring vs. class instruction when instructional time and teacher differences were controlled. Their tutor sample consisted of twenty preservice teachers, half of whom were sophomores with no formal instruction in teaching methods and half of whom had completed all required courses in teaching methods and most of their student teaching. The tutored subjects were 120 fourth and fifth grade students drawn from twenty classrooms in three elementary schools. All students were classified as low, medium, or high ability subjects based on their Primary Mental Abilities IQ score. Each teacher was assigned two students at each ability level, and these pairs of students were then randomly assigned to be individually tutored or instructed in the classroom setting. Both tutoring and classroom instruction were conducted for thirty minutes on each of two days per week. One week before the experiment, each teacher was given eight specific instructional objectives relating to exponential notation with examples and a brief mathematical discussion of each objective. The pre and posttests consisted of sixteen items, two for each of the eight objectives. The results of the study showed that tutoring produced significantly greater student achievement than classroom instruction but

that teacher experience and training did not affect overall achievement of the unit's objectives nor did they interact with student ability level or instructional method. In the present study of teachers as tutors, comparisons were made between individual and classroom instruction.

In a 1974 study, Stowitschek and Hofmeister attempted to validate Minicourse 5 (the tutor training vehicle in this study) for special education teachers and students. Of twenty-five teachers of educable mentally retarded children, fifteen were randomly assigned to the experimental group (to receive Minicourse 5 training and tutor) and the remaining ten teachers were assigned to the control group (to conduct regular classroom activities). Mathematics achievement of pupils in both the experimental and control groups was measured by pre and posttests using the Level I mathematics section of the Wide Range Achievement Test and a locally developed mathematics test, the Content Referenced Test. The researchers reported that statistically significant differences in mathematics performance occurred in favor of students tutored by special education teachers trained with Minicourse 5 over students who were not tutored. Teacher data on the use of Minicourse 5 tutoring techniques were collected from the experimental teachers and analyzed using both a t test for correlated means and the Wilcoxon matched-pairs, signed-ranks test. Teachers demonstrated little change in the use of prompting and praising techniques or in the use of teacher declaratives. Teachers' use of diagnostic questions increased the greatest amount when both postcourse and delayed postcourse video tape samples were compared to the precourse video tape samples ($p < .05$, $p < .001$). The researchers concluded that the validity of Minicourse 5 was supported in terms of improving teachers' ability to tutor and a concomitant increase in measurable mathematics achievement by their students.

While the results of this study were positive, a plausible competing hypothesis could be stated that the pupils who were tutored received more mathematics instruction than did the control pupils; however, in the study reported herein, instructional time in mathematics was controlled.

Tutoring and Affective Outcomes

In addition to investigating the effects of tutoring on achievement, researchers have explored its affective outcomes. The search of the literature on affective outcomes sought to identify both variables and instruments to assess those variables. General research findings in the areas of self-concept, attitude towards mathematics, and locus of control are discussed below.

Self-Concept

Self-concept is defined as the perceptions a person has about his own worth. In studying the general and academic self-concept of pupils, researchers have had the same problem faced in any attitude research, i.e., the difficulty of determining whether the specific affective test measures the concept in question. In addition, researchers have had the problem of developing and administering reliable affective tests to young children. Despite these difficulties, several studies have found that the self-concept of pupils was increased as a result of tutoring (see Haggerty, 1970; Dillner, 1971; Robertson, 1971; and Erb, 1972).

Among the instruments that were used to assess self-concept, one of the few scales which included general and mathematics self-concept was the Sears Self-Concept Inventory (Sears, 1964). The internal consistency coefficients for general and mathematics self-concept were .91 and .93

respectively, as reported by Smith and Hess (1972). The scale was modified to include academic and mathematics self-concept and used as a dependent measure in the present study.

Attitudes

Research studies that investigate student attitudes often are difficult to interpret for three reasons: (1) unclearly defined types of attitudes, (2) measuring instruments with low validity, and (3) poor control of extraneous variables (Knaupp, 1973). In spite of these difficulties, researchers have attempted to measure elementary students' attitudes about mathematics, usually with one of three popular attitude instruments--a semantic differential scale, a Thurstone-type test, or a Likert-type scale. These tests have been used to find out how elementary students feel about mathematics, per se, with no intervening treatment (Dutton & Blum, 1968; Scharf, 1971; and Callahan, 1971) and to discover whether there is a positive correlation between mathematics attitude and achievement (Shapiro, 1961).

Mastanterono & Anttonen (1970) studied the predictive value of four mathematics attitude scales with third and fifth grade students. The Dutton-Thurstone Scale, the Dutton-Likert Scale, a Guttman-type Hoyt Scale, a version of the Semantic Differential Scale, the Iowa Math Battery, and the Lorge-Thorndike IQ test were administered to all students. The authors studied the intercorrelations among the attitude instruments and relationships between attitude and achievement. Among the attitudes tests, the Dutton-Likert Scale showed the highest correlation with mathematics achievement for the majority of the students ($r = .367$, $p < .01$). This instrument was used in the present investigation.

Attitude toward mathematics has been studied in terms of its being a possible positive effect of tutoring. However, given a dissatisfaction with the measuring instruments available, it is perhaps understandable that many tutoring studies have concentrated on showing achievement gain and have not concerned themselves with collecting reliable data on attitude change as a result of tutoring. The few tutoring studies which have used an attitude scale as a dependent variable have reported a positive shift in student attitude toward mathematics--an effect the researchers directly related to the tutoring strategies employed in the studies (Cairnes, Barnes, and Letson, 1971; Erb, 1972). Obviously, more research needs to be done in this area.

Locus of Control

The concept of locus of control, originally studied by Battle and Rotter (1963) in their inquiries into the effects of reinforcement on learning, has recently been studied in additional areas--most notably in terms of whether internal/external control of reinforcement relates to educational success and failure. As defined by Rotter (1966), "internal control represents a person's belief that rewards follow from, or are contingent upon, his own behavior." External control, conversely, "represents the belief that rewards are controlled by forces outside himself and thus may occur independent of his own actions" (Gurin, et al., 1969).

Although no tutoring studies could be found in which locus of control was used as a dependent measure, it seemed logical to include external locus of control as a high risk variable under the premise that the dynamics of the tutoring setting could be expected to give a pupil a feeling of more control in the area of mathematics.

Summary

The existing literature on tutoring underscores both the need for further research in this field and some of the key questions to which answers should be sought. While there are numerous reports in the existing literature of the positive effects on students of tutoring, they leave important questions unanswered because of methodological inadequacies. Many studies did not include a description of the tutor training procedures that were employed. In others, the number of subjects was small and/or arbitrarily chosen without regard to specified criteria, making generalizability limited. Still others failed to specify the activities that occurred during tutoring sessions. Nevertheless, the existing research provided a necessary point of departure in the search for psychologically and educationally meaningful variables and in the formulation of the research questions to be answered.

SECTION TWO

METHODOLOGY

CHAPTER III

DESIGN OF THE STUDY

The Math Tutoring Study: Paraprofessionals as Tutors was conducted with fourth and fifth grade pupils to answer questions concerning the effect of tutoring on mathematics achievement, self-concept as it relates to mathematics, attitude toward mathematics, and external locus of control as it relates to mathematics. It also sought to investigate the relationship of certain tutoring skills to positive pupil outcomes in the aforementioned areas.

Treatment Conditions

The design of the present study identifies three treatment conditions:

1. Mini 5 and mathematics trained tutors, in which paraprofessional tutors received training in certain specified tutoring skills through Minicourse 5 (see Appendix A) and training in specific mathematics skills and concepts and then tutored each of six pupils individually in four fifteen-minute sessions per week for nine weeks.

2. Mathematics only trained tutors, in which paraprofessional tutors received training only in specific mathematics skills and concepts and then tutored each of six pupils individually in four fifteen-minute sessions per week for nine weeks.

3. Control treatment to which no paraprofessional tutors were assigned.

Pupils in both tutoring treatment conditions continued to receive regular mathematics instruction from their classroom teachers along with their classmates. The tutoring sessions, held at the same time each day in a spare room of the school, were scheduled so that pupils were not absent from regular mathematics instruction in their classrooms.

The control group consisted of pupils who did not receive regular, consistent tutoring by paraprofessionals but instead participated only in ongoing classroom activities in common with the pupils in both treatment conditions. The pupils selected for the control group were pre and post tested at the same time as tutored pupils.

Pupils both above and below their school's median mathematics achievement were included in the two tutoring treatment conditions and in the control group. (The selection and testing of pupils are described in Chapter IV.) This was done to permit studying whether or not tutoring had differential effects upon pupils above and below median in mathematics achievement.

Tables 1 and 2 illustrate the design of the study, indicating the number of tutors in each treatment condition, and the number and ability levels of the tutored pupils.

Details on the selection and assignment of paraprofessionals and pupils to treatments are provided in Chapter IV. Determination of the number of ability levels is contained in the results section of this report.

Based on this design, it was possible to consider the effects upon students that could be related to the tutoring process itself. It was also possible to investigate the relationship between specific tutoring skills and pupil outcomes.

TABLE 1

Tutors and Pupils by Treatment and Ability Level
Grade 4

Ability Levels	Minicourse 5 + Mathematics Trained Tutors n = 16*	Mathematics Only Trained Tutors n = 15	Control Group (No Tutors)
4 (high)	5	7	15
3	10	10	21
2	26	15	29
1 (low)	5	5	10

TABLE 2

Tutors and Pupils by Treatment and Ability Level
Grade 5

Ability Levels	Minicourse 5 + Mathematics Trained Tutors n = 16*	Mathematics Only Trained Tutors n = 15	Control Group (No Tutors)
4 (high)	6	11	14
3	15	10	20
2	15	14	22
1 (low)	10	8	9

*For illustrative purposes, the numbers in Tables 1 and 2 pertain only to the Comprehensive Tests of Basic Skills (CTBS). It should be noted that the numbers in the various cells will be different for each dependent variable.

Fidelity of Treatment

In order to study the effects of tutoring, it was important that the treatment conditions be in operation over a reasonable period of time. It was originally planned that the duration of the study would be nine weeks, from the week of February 18 until the week of April 22, 1974. While tutoring began as scheduled, it was interrupted after three weeks by a strike of the employees of the city of San Francisco. As many school employees (custodians, engineers, etc.) are hired by the city of San Francisco, picket lines were established at all schools, and, therefore, no tutoring could occur. Beginning the week of March 11, 1974, all tutors were put on half-time pay and told to wait for notification from the Research Unit staff concerning a decision to continue the study or not. The decision was made to discontinue the study if the strike was not settled by Friday, March 29, 1974. As the strike was settled early in that week, the study was continued. All tutors were called together for a meeting on Friday, March 29, and tutoring resumed on April 1. In all, the study was interrupted for a total of three weeks, but after its resumption, continued for six more weeks until May 17, 1974, thus giving a tutoring treatment of nine weeks. Questions regarding the impact of this interruption in the tutoring process will be considered in the results section of this report. It is apparent that a consequence of the strike was to reduce the strength and fidelity of the treatment.

Tutors who participated in the study were required to keep a daily log (see Appendix B) in which they recorded for each tutoring session the name of the tutored pupil; the mathematics area in which the tutoring occurred, e.g., addition of simple numbers, subtraction of fractions,

etc.; an estimation of the progress that the tutored pupil made during that tutoring session; and the total number of minutes the tutoring session lasted. In addition, the log provided space for any additional comments tutors wanted to make.

Tables 3 and 4 present data regarding the average number of minutes that each pupil was tutored per week. The average time in tutoring for all fourth and fifth grade pupils, as reported in the following narrative, therefore provides an indication of the fidelity of treatment for these groups. As shown in Tables 3 and 4, there was the potential for six tutors in each of the nine schools--three in each of the treatments. Data are recorded for only those tutors who returned after the strike.

If each pupil had received the full amount of tutoring during each scheduled session, there would have been a total of 60 minutes of tutoring per week for each pupil. However, because of many unexpected events which can occur in the school setting, the optimum treatment was received by only 23 (12% of the sample) pupils in the study. An average of 42 minutes of tutoring per week was seen as tolerable and 91% of the fourth and fifth grade pupils received at least this minimum amount of tutoring. It should be noted that none of the tutors was consistently below the desired time with all of his/her pupils.

As could be expected, tutors did not turn in complete log sheets for each of the nine weeks of the study. Table 5 illustrates the percentage of logs that were turned in by each tutor.

TABLE 3

Total Number of Minutes Per Week Spent in Tutoring

by Tutor and Pupil

Grade 4

		Mini 5 Tutors			Regular Tutors		
School	Pupil	Tutor 1	Tutor 2	Tutor 3	Tutor 1	Tutor 2	Tutor 3
1	1	40.3	44.2			51.3*	
	2	55.0*	34.1*			38.0*	
	3		54.6			40.2*	
2	1	56.2	56.1	50.7	39.2		43.1*
	2	54.3*	52.8	55.2	50.9		51.7
	3			52.0			50.0
	4			45.4			
3	1	61.9	54.4	49.1*	52.9	46.3	
	2	56.9	58.8*	51.0*	49.3	51.7	
	3	45.9	56.1	53.6			
4	1		61.1			63.4	59.4
	2		65.6			61.0	59.6
	3						
5	1	52.0*			60.1	56.7	
	2	58.0*			57.1	51.7	
	3						
6	1	47.3	52.7		51.0	26.0*	
	2	49.9	67.9*		45.4*	50.0*	
	3	41.1	51.8			53.3	
	4					30.0*	
7	1		43.4		46.7*		
	2		63.3		49.4*		
	3		56.9*		53.8*		
	4		47.2*		37.5*		
8	1	51.9			50.1*		
	2	61.8					
	3	52.1					
	4	54.1					
	5	54.1*					
9	1	58.6*			64.8	61.7	
	2	50.4*			57.2	59.4	
	3	46.6*				48.8	
	4	53.5*				64.1*	

*time based on less than nine weeks of logs

TABLE 4

Total Number of Minutes Per Week Spent in Tutoring

by Tutor and Pupil

Grade 5

		Mini 5 Tutors			Regular Tutors		
School	Pupil	Tutor 1	Tutor 2	Tutor 3	Tutor 1	Tutor 2	Tutor 3
1	1	33.2*	52.1			43.0*	
	2	40.0	52.2			50.8*	
	3	47.8	32.3			53.0*	
2	1	51.7	60.3	52.9	39.4		47.2
	2	45.4*	44.8	52.9	37.3*		51.4*
	3	47.6*			42.8		43.9
	4	50.3			41.3		
3	1	54.0	45.6	50.4*	41.9*	54.9	
	2	46.1*	58.7	39.9*	49.7	57.4	
	3	46.9*	52.8		55.8	49.1	
4	1		58.3			62.3	62.6
	2		57.8			65.9*	57.2
	3		65.0*			64.3	56.1
	4						55.0
5	1	80.0*			55.2	53.8*	
	2	59.0*			61.7	48.9	
	3	51.3*			62.3*	44.2*	
	4	53.0*					
6	1	51.0	54.3		53.6*	43.3	
	2	36.0	55.4		49.9	53.3	
	3	41.6	55.4*		56.8		
	4				52.0*		
7	1		58.9		48.8*		
	2		89.4		58.6*		
	3						
8	1	39.9	41.3		59.1*		
	2		44.8		50.0*		
	3		47.6*		60.6*		
	4		53.9	53.6*			
	5		55.8				
9	1	49.8*			48.9	61.1	
	2				52.4	58.6	
	3				58.1		
	4				55.7		

*time based on less than nine weeks of logs

TABLE 5

Percentage of Tutor Logs Received*

School	Minicourse 5 Tutors			Regular Tutors		
	Tutor 1	Tutor 2	Tutor 3	Tutor 1	Tutor 2	Tutor 3
1	96	93	--	--	59	--
2	93	100	100	98	--	94
3	96	98	82	96	100	--
4	--	98	--	--	98	100
5	54	--	--	98	91	--
6	100	98	--	93	65	--
7	--	96	--	81	--	--
8	98	98	--	89	--	--
9	87	--	--	96	98	--

*All tutors turned in logs. Empty spaces in table indicate no tutor.

The high percentage of tutor logs received from tutors in both tutoring treatments offers support for the assumption that the treatment in fact did occur. It is our opinion that the research controls and treatment conditions were sufficiently well maintained, regardless of the intervention of the strike, to permit answering the questions to which the study is addressed.

CHAPTER IV

METHODOLOGY

The study was conducted in the San Francisco Unified School District, serving San Francisco, California. Reflecting the cosmopolitan character of the city's population, the district enrolls pupils from a broad socio-economic spectrum and diverse ethnic and racial backgrounds. For the 1972-73 school year, the median achievement scores for pupils in the district were in the 19th, 31st, 40th and 28th percentiles for reading, language, spelling and mathematics, respectively. Median class size was 25.0 for kindergarten through eighth grade, and the median teacher's salary was $13,441 (California State Department of Education, 1974).

Nine intermediate schools (enrolling pupils in grades 4 through 6) were the sites of the study. They were selected consistent with two criteria. First, the principal and fourth and fifth grade teachers in each of the schools expressed willingness to cooperate with the requirements of the research. Second, the schools reflected in their enrollments the diversity of the city's population.

Selection of Tutors

Paraprofessionals were recruited and employed by the Far West Laboratory for Educational Research and Development to serve as tutors for the study.

A recruitment brochure, describing the positions and inviting applications, was distributed through principals of the schools selected as potential sites and through a number of community organizations and the school district's paraprofessional office. The resulting applications

were screened by the district's paraprofessional office. Those candidates who met the district's minimum requirements for paraprofessionals were invited to a personal interview.

Interviews were conducted with 110 applicants at the offices of the Far West Laboratory by a two-member panel--one member from the school district's paraprofessional office and a Laboratory employee familiar with the study. Each applicant was interviewed individually for approximately fifteen minutes to assess his/her:

1. enthusiasm for the tutoring tasks to be performed;
2. attitudes toward children generally and experience in working with nine- and ten-year olds;
3 willingness to accept assignment to any of the nine participating schools;
4. general educational background and familiarity with basic mathematical concepts and skills.

Each candidate was evaluated independently by the two interviewers, using the instrument reproduced in Appendix C. The applicant's final score was computed by averaging the scores assigned by the two interviewers, and those applicants with the highest scores were offered tutoring positions for the duration of the study.

The foregoing recruitment and selection process resulted in 49 adults being selected to serve as tutors. Of this total, 15 tutors were male and 34 were female. The group included Asians, Latinos, Blacks, Whites, and Native Americans. Ages spanned a wide range; some tutors were college students, some were parents of school-age children, and some were retired. While a few formerly had been teacher aides, none was currently employed in the public schools.

The delay and the extension of the study to compensate for the time lost during the school district employee strike made it impossible for 17 of the tutors to continue. Thus, when tutoring was resumed after the schools reopened, 32 tutors remained--8 males and 24 females. However, because an additional tutor left before the conclusion of the study, the data reported here are limited to 31 tutors--7 males and 24 females.

Assignment of Tutors

Tutors were stratified by sex and then randomly assigned to treatment conditions, approximately one-half of each sex to receive training in both mathematics skills and Minicourse 5 tutoring skills and one-half to receive mathematics training only. The tutors assigned to each treatment condition then were separately assigned at random to the nine participating schools, ensuring that tutors in both treatment conditions were assigned to each school and that at least one male and one female tutor were assigned to each. The number of tutors assigned to each school varied, depending upon the number of tutors the principal had decided could be accommodated in the particular school.

The reduction from 49 to 31 tutors occasioned by the strike is not considered to have had intolerable effects upon tutor assignments. An almost equal number of tutors dropped out of each of the two treatment conditions, leaving 16 tutors in the Minicourse 5 and math trained condition and 15 tutors in the math-only trained condition. In both treatments, some of the remaining tutors were male, and both treatment conditions continued to be present in each of the nine participating schools. In two of the schools, however, the reduction in the number of paraprofessionals did result in there being no male tutors assigned. Table 6 reports tutor assignments to treatment conditions by sex and school.

TABLE 6

Number of Tutors Assigned to Treatment Conditions

by Sex and School*

School	Mini 5 and Math Trained Tutors		Math Only Trained Tutors		Total
	Male	Female	Male	Female	
1	0	2	1	0	3
2	1	2	1	1	5
3	1	2	0	2	5
4	0	1	0	2	3
5	1	0	0	2	3
6	0	2	1	1	4
7	0	1	0	1	2
8	0	2	0	1	3
9	0	1	1	1	3
Total	3	13	4	11	31

*After attrition resulting from strike closure of schools.

Selection of Pupil Sample

The available population for the study was comprised of those fourth and fifth grade pupils in the nine schools: (1) whose teachers had agreed to permit their pupils to participate, (2) who were not classified by the school either as being gifted or as having learning disabilities, and (3) who were fluent in English. This population first was stratified by grade and sex and then pupils within each stratum were randomly selected for participation.

The selected pupils were pretested from October 29 to November 9, 1973, using the following instruments:

1. The Modern Mathematics Supplement to the Iowa Tests of Basic Skills (ITBS)
2. The computation section of the Comprehensive Tests of Basic Skills (CTBS), Level 2
3. The Dutton-Likert Attitude Toward Mathematics Scale (ATMS) and a locus of control instrument called Feelings About Math
4. The Modified Sears Self-Concept Inventory, which for purposes of this study was called About Myself (AbMy) and contained an Academic Self-Concept and a Math Self-Concept scale.

A detailed discussion of these instruments follows later in this chapter.

Testing was conducted in each of the participating schools by trained examiners from the Far West Laboratory. Fourth and fifth graders were tested separately on both of two testing days, completing one attitude measure and one mathematics achievement test each day. All tests were group administered, and make-up tests were scheduled for absent pupils. (Details of instrument administration are provided later in this section.)

Median splits for the ITBS and CTBS were performed for each school by grade level (Table 7). As may be seen by examining these data, the median scores varied significantly among the schools. On the ITBS, school medians for fourth grade pupils ranged from 8.0 to 20.0 with the medians for all but one school between 8.0 and 12.0. Fifth grade ITBS school medians ranged from 6.0 to 14.0, with the medians for seven of the nine schools between 11.0 and 14.0. On the CTBS, medians for fourth graders ranged from 7.0 to 24.0, with medians for one group of five schools between 21.0 and 24.0 and for a second group of three schools between 13.0 and 14.0; the ninth school's median was 7.0. For fifth graders, school medians on the CTBS again were clustered in two groups, with three schools having medians between 17.0 and 21.0 and six in a range between 25.0 and 33.0. Inasmuch as all schools contained each of the three treatment conditions, and pupils within ability levels were randomly assigned to treatments, it was assumed that there would be homogeneity of variance among the pupils in the various treatments.

Preliminary examination of the data in Table 7 led to the decision to use the median CTBS scores to classify pupils as being above or below median in mathematics achievement for their grade level within a particular school. There was considerably more variance in the CTBS scores than in the ITBS scores, thus enabling more accurate ability classifications.

Two-thirds of the participating pupils within each of the schools--stratified by grade level, sex, and above/below median CTBS achievement--were then randomly selected to receive mathematics tutoring. The participaging pupils not selected for tutoring were considered to be inschool controls.

TABLE 7

Median Pretest Scores on the ITBS and CTBS for All Participating Pupils by School and Grade Level

School	ITBS (36 items)				CTBS (48 items)			
	Fourth Grade		Fifth Grade		Fourth Grade		Fifth Grade	
	Raw Score	Grade Equiv.	Raw Score	Grade Equiv.	Raw Score	Grade Equiv.	Raw Score	Grade Equiv.
1	9.0	2.9	8.0	3.3	13.0	3.1	21.0	3.9
2	20.0	4.8	14.0	4.5	23.0	4.1	31.0	4.8
3	9.0	2.9	11.0	3.9	20.0	3.8	26.0	4.4
4	10.0	3.0	14.0	4.5	24.0	4.2	33.0	5.0
5	12.0	3.4	13.0	4.3	22.0	4.0	25.0	2.9
6	10.0	3.0	9.0	3.5	7.0	2.4	17.0	2.1
7	8.0	2.8	6.0	2.9	13.0	3.1	18.0	2.3
8	11.0	3.2	11.0	3.9	14.0	3.2	25.0	4.3
9	11.0	3.2	13.0	4.3	21.0	3.9	31.0	4.8

Assignment of Pupils to Paraprofessionals

The pupils within each of the nine schools who had been selected for tutoring were randomly assigned to paraprofessionals. The paraprofessionals, in turn, had been randomly assigned to schools and treatment conditions, as described previously.

Each paraprofessional tutor was assigned six pupils. Assignments were made without regard to the pupils' classroom assignments--that is, without any attempt to insure that the pupils were drawn from different or the same classrooms. In effect, however, it was rare for any tutor to be assigned more than three pupils from a single class.

Of the six pupils assigned to each tutor, three had scored above and three below the grade level median for their school on the CTBS. In each case, the six pupils were evenly divided between fourth and fifth graders, and at least one pupil of each sex was included.

Following the closure of the schools by strike, the pupils assigned to the 17 tutors who were unable to continue in the study were dropped from participation. Since tutors dropped about equally from both treatment conditions, the number of pupils receiving tutoring under each condition also remained approximately equal. Moreover, because each tutor had been assigned an equal number of fourth and fifth graders and of pupils above and below median achievement, the loss of 17 tutors did not affect the proportionate composition of the pupil sample in these dimensions.

Characteristics of the Pupil Sample

Analysis of variance was performed for each pre-measure at each grade level to determine the correctness of the assumption that the pupils assigned to the different treatments were from a common population.

Analysis of variance assumes: (a) uncorrelated, normally distributed errors of measurement with equal variances, and (b) additive effects. From the regression analyses (see Chapter VI), we are reasonably certain a linear (additive) model with normally distributed errors exists. Since there is no reason for error correlation between treatment groups to exist, the remaining test is for equality of error variance. This is done by checking for equality in treatment group variance of the dependent variable. A routine check on this latter assumption was made (See Tables D-1 through D-12 in Appendix D. These tables also include a standard presentation of the analysis of variance [ANOVA] results for pretest scores on each instrument.)

According to Glass, et al. (1972), ANOVA is robust to the homogeneity of variance assumption and only "major" violations in combination with large variance ratios significantly affect the probability of a Type I error in testing the treatment means. In this study there appears to be no serious violation of the equal error variance assumption, and hence the actual Type I error probabilities for reported means probably vary little around their reported values. If the means are statistically equal across the treatment groups, then the assumption of a common population is valid.

The analysis of variance results for the fourth and fifth grade CTBS pre-measures are presented in Appendix D, Tables D-1 and D-2. The results for CTBS in grades four and five show F ratios of 1.40 and 0.74, respectively, with corresponding Type I error probabilities (F PROB) of 0.24 for fourth grade and 0.48 for fifth grade, indicating that the means of the three treatment groups were not significantly different. The statistic used to test the homogeneity of variance is the Cochran's C test (c.f. Winer, 1962). For these tables the fourth grade showed a C = 0.39 with an approximate

probability of occurrence of 0.31, and the fifth grade, C = 0.41 with an appropriate probability of occurrence of 0.18. In both cases the assumption of homogeneity of variance was met.

These values and the ninety-five percent confidence intervals on group means were calculated by the One-Way Analysis of Variance: Subprogram ONEWAY computer program (Nie and Hull, 1973). There was a considerable overlap in these intervals, offering further evidence that none of the groups had a starting advantage on the percepts measured by the CTBS prior to treatment.

The fourth and fifth grade analysis of variance results for the ITBS pre-measures are presented in Tables D-3 and D-4. The F ratios for the fourth and fifth grade ITBS were both less than one indicating that the means among the three treatment groups were not significantly different at either grade level. However, Cochran's C of 0.48 ($p = 0.01$) for the fifth grade ITBS indicated that there was not homogeneity of variance among the three fifth grade treatments. ANOVA is robust to this minor violation of the assumption of equal variances, but later results of the fifth grade ITBS will be interpreted with caution, nonetheless.

The ANOVA results for the affective measures at both grade levels also are included in Appendix D. None of the F ratios for the affective measures approached traditional levels of significance again indicating that the means among the three treatments for each premeasure at either grade level did not differ significantly. Cochran's test for homogeneity

of variance indicated that the assumption of equal variance was met in seven of the eight possible cases, the exception being the fifth grade locus of control premeasure. On that measure, Cochran's C of 0.47 with an approximate probability of 0.02 indicated that the variances of the three treatment conditions were not equal. Data reported in Table D-12 show that the variance in the second treatment was slightly larger than that of the other two treatments for this measure. Even though ANOVA is robust to this violation, later results of the fifth grade locus of control measure also will be interpreted with caution.

Summary

The preceding results largely confirm the assumption that all treatment groups were from a common population. Of the twelve analyses of variance which were performed on the six premeasures, none had differences which reached conventional levels of significance. Cochran's test for homogeneity of variance, however, showed that two of the fifth grade measures reached conventional levels of significance. A C of 0.48 with an approximate probability of occurrence of 0.01 was obtained for the fifth grade ITBS and a C of 0.47 with an approximate probability of 0.02 was obtained for the locus of control measure. In both cases, the result was due to larger variance in the Mathematics Only Trained Tutor treatment.

Although there were two violations of the assumption that all treatment group pupils were from a common population, neither violation was of a serious nature. We will, however, interpret the results of those two measures (fifth grade ITBS and locus of control) with caution.

Pupil Variables and Instruments

The pupil variables of interest to the present study were:

(1) Mathematics achievement, which was measured by the Modern Mathematics Supplement of the Iowa Tests of Basic Skills (ITBS) and the computational section of the Comprehensive Tests of Basic Skills, Form Q, Level 2 (CTBS)

(2) Academic and mathematics self-concept, which were measured by different subscales of the Modified Sears Self-Concept Inventory

(3) Attitude toward mathematics, which was assessed with the Dutton-Likert Attitude Toward Mathematics Scale

(4) External locus of control, which was assessed by the Feelings About Mathematics scale embedded in the Attitude Toward Mathematics Scale

Each of these four pupil variables will be discussed next, immediately followed by a discussion of the instrument(s) used to measure it.

Mathematics Achievement

For the purposes of this study, mathematics achievement is defined in terms of the score that a pupil receives on a mathematics achievement test. The mathematics areas generally covered in fourth and fifth grade are computation, measurement, currency, decimals, fractions, and understanding of mathematical concepts. In this study, mathematical concepts were measured by the Modern Mathematics Supplement of the Iowa Tests of Basic Skills (Lindquist, et al., 1968), and computational skills were measured by the computation section of the Comprehensive Tests of Basic Skills, Form Q, Level 2 (CTBS, 1968).

ITBS. The ITBS was identified as being sensitive to the content contained in the Houghton-Mifflin state adopted mathematics textbooks which were used as the primary text in each of the participating schools. The mathematics areas covered by the fourth grade portion of the ITBS are: (1) currency; (2) equations, inequalities, and number sentences; (3) fractions; (4) geometry; (5) measurement; (6) numeration and number systems; and (7) whole numbers. The fifth grade portion of the ITBS covers all of the preceding mathematical areas with the exception of currency and, in addition, ratio and proportion and sets. The test is constructed in a multi-level format in which there are six overlapping levels, one for each of grades three through eight-nine. Pupils in this study were given either the fourth or fifth grade level form.

Psychometric data were computed for all instruments in the study based on the sample used for analyses. The ITBS pre-scale mean for the fourth graders who participated in the study was 13.0, the standard deviation was 7.3, with an alpha of .89 and a standard error of measurement of 2.5. The number of fourth grade pupils (n) taking the pre test was 162. On the ITBS post, the scale mean for fourth graders was 17.0, the standard deviation was 8.6, with an alpha of .92 and a standard error of measurement of 2.5. The fourth grade n on the ITBS post was 162.

The ITBS pre-scale mean for fifth graders was 13.3 with a standard deviation of 7.1. The alpha coefficient was .85 with an error of measurement of 2.7. The fifth grade n on the pretest was 158. On the ITBS post, the fifth graders obtained a scale mean of 17.1, with a standard deviation of 7.8, an alpha of .87, and a standard error of

measurement of 2.8. The fifth grade n was 158 on the post measure. These psychometrics are summarized in Table 8 on page 43.*

CTBS. The CTBS consists of 48 computational items which are divided among addition, subtraction, multiplication, division, fractions, and decimals. In this study, the total score on the CTBS is used as an independent or dependent measure. The pre CTBS scale mean for fourth grade pupils was 18.9. The standard deviation was 9.8 with an alpha of .93 and a standard error of measurement of 2.6. The scale mean for fourth graders on the post CTBS was 25.9, and the standard deviation, alpha, and standard error of measurement were 11.9, .94, and 2.6, respectively. The fourth grade n was 162 on both the pre and post CTBS.

For fifth graders, the pre CTBS scale mean was 26.3, with a standard deviation of 10.7, an alpha of .93, and a standard error of measurement of 2.7. The n was 158. On the post CTBS, the fifth grade scale mean was 28.1, and the standard deviation was 11.4 with an alpha of .94 and a standard error of measurement of 2.8. The post CTBS n was 158. These psychometrics are summarized in Table 8 on page 43.

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*For more complete psychometrics on all instruments, including item means, standard deviations, and item-scale correlations, the reader is referred to Appendix E. Copies of the instruments used in the study also are included in Appendix E.

Self-Concept

Self-concept is defined as the perceptions that one holds concerning his own worth. In this study, both academic and mathematics self-concept were examined, although the primary concern was self-concept as it relates to mathematics. Both these areas were assessed with the Modified Sears Self-Concept Inventory which was called About Myself (AbMy) and consisted of an Academic Self-Concept subscale and a Mathematics Self-Concept subscale.

Academic self-concept, as defined by Sears, consists of convergent and divergent mental processes, work habits, and perceptions of school subjects. Mathematics self-concept was assessed on a separate subscale.* Pupils were instructed to read each item as it was read aloud to them and answer the question, "Compared to other boys and girls my age, how do I rate now?" Their answers to these questions were then entered on the answer sheet into one of five categories: excellent, very good, better than most, OK, or not so good.

Prior to using About Myself in this study, test-retest reliability coefficients were obtained over a one-month period with a pilot sample of 110 pupils equally divided between the fourth and fifth grades. The Pearson r's for the academic self-concept subscale and the mathematics self-concept subscales were .56 and .64, respectively.

Participating fourth grade pupils in this study received a pre-scale mean of 95.6 on the academic self-concept subscale, with a standard deviation of 18.1. Coefficient alpha was .88 and the standard error of

*The math-specific items were developed by the staff of the Far West Laboratory with assistance from Ronald Marks of the Stanford Research and Development Center, Stanford University.

measurement was 6.3. On the pre-mathematics self-concept subscale, the scale mean for fourth graders was 24.7 and standard deviation was 6.7 with an alpha of .75 and a standard error of measurement of 3.4. The fourth grade n on both pre measures was 161. On the post academic self-concept measure for fourth grade, the scale mean was 94.4, the standard deviation was 20.8, and the alpha and the standard error of measurement were .92 and 5.9, respectively. The scale mean for the post mathematics self-concept subscale was 27.0 with a standard deviation of 6.8. Coefficient alpha was .79 and the standard error of measurement was 3.1. The fourth grade n for both post measures was 157.

The pre-academic self-concept scale mean for fifth graders was 95.8 with a standard deviation of 19.4, an alpha of .91, and a standard error of measurement of 5.9. On the pre mathematics self-concept measure, the scale mean was 26.0 with a standard deviation of 6.6, an alpha of .77, and a standard error of measurement of 3.2. The fifth grade n on both pre measures was 156. The fifth grade pupils received a scale mean of 97.1 on the post academic self-concept measure, with a standard deviation of 22.0, an alpha of .94, and a standard error of measurement of 5.5. For the post-mathematics self-concept measure, fifth grade pupils received a scale mean of 28.0, with a standard deviation of 7.1, an alpha of .84, and a standard error of measurement of 2.8. The fifth grade n on both post measures was 157. These psychometrics are summarized in Table 8 on page 43.

Attitude Toward Mathematics

Attitude refers to a learned predisposition or tendency on the part of a person to respond negatively or positively toward some object,

situation, concept, or person. In this study, attitude toward mathematics was examined. The Dutton-Likert Attitude Toward Mathematics Scale (ATMS) was used to assess this pupil variable.

At the time the instrument was administered, pupils were instructed to read each item as it was read aloud to them and respond to the statements by placing a mark in the appropriate box on the answer sheet to indicate whether they strongly agreed, agreed, disagreed, or strongly disagreed with a particular item. A list of definitions of the more difficult words in the scale was provided by the authors of the test, and each examiner incorporated those definitions into the second reading of each item.

Using the previously mentioned sample of 110 fourth and fifth grade pupils, the ATMS was piloted. A test-retest reliability coefficient of .69 was obtained over a one-month period.

Fourth graders who participated in the study reported here received a pre-scale mean on the ATMS of 50.5 with a standard deviation of 10.1, an alpha of .81, and a standard error of measurement of 4.4. The pre ATMS fourth grade n was 161. On the post ATMS, a scale mean of 49.8 was obtained; the standard deviation was 11.1, with an alpha and standard error of measurement of .86 and 4.2, respectively. The n for fourth graders on the post ATMS was 160.

The pre ATMS for fifth grade pupils had a scale mean of 48.3 and a standard deviation of 10.3, with an alpha of .84 and standard error of measurement of 4.1. The pre ATMS n for fifth graders was 157. On the post ATMS, fifth grade pupils received a scale mean of 48.1, a standard deviation of 10.1, an alpha of .84, and a standard error of measurement of 4.0. The fifth grade post ATMS n was 154. These psychometrics also

are summarized in Table 8 on page 43.

External Locus of Control

External locus of control refers to the belief that rewards are controlled by forces other than one's self and thus may occur capriciously and independent of one's actions. In this study, external locus of control was examined as it relates to a pupil's perception of the reinforcement which influences him in the area of mathematics. Locus of control was assessed by the Feelings About Math Scale (FAMS) which was embedded, in random order, in the Attitude Toward Mathematics Scale.

The items on the FAMS were taken from a pool of internal/external items developed by various researchers in the locus of control field (Bialer, Cromwell, 1961; Morrison, 1967; Rotter, 1966; Crandall et al., 1965; Clifford, 1971). Each item in the pool was adapted so that it was (1) specifically oriented toward mathematics, (2) marked on a four-point scale, and (3) worded in the first person.

A preliminary version of the scale, which contained 58 internal and external items, was pilot tested in June, 1973, with 50 fourth and 50 fifth grade pupils. Analysis of the results led to the elimination of items which had low reliability, and the final version of the scale was pilot tested in July and August of 1973 with 110 fourth and fifth grade pupils. A test-retest reliability coefficient of .63 was obtained over a one-month period during this pilot.

In administering the FAMS, pupils were instructed to read the items silently as they were read aloud by the examiner and respond to each statement by checking the answer sheet to indicate whether they strongly agreed, agreed, disagreed, or strongly disagreed. Each item was read twice.

For fourth grade participants, the pre FAMS scale mean was 26.2, the standard deviation was 4.4, coefficient alpha was .64, and the standard error of measurement was 2.6. The pre FAMS fourth grade n was 161. The post FAMS fourth grade scale mean was 27.6 the standard deviation was 4.3, the alpha was .66, and the standard error of measurement 2.5. The n for fourth grade pupils on the post FAMS was 160.

Fifth graders who participated in the study received a pre FAMS scale mean of 27.0 with a standard deviation of 4.9. Coefficient alpha was .73 with a standard error of measurement of 2.5. The n was 156. The fifth grade scale mean on the post FAMS was 28.5, with a standard deviation of 4.4, an alpha of .69, and a standard error of measurement of 2.4. The post FAMS n for fifth graders was 154. These psychometrics are summarized in Table 8 on page 43.

Table 8 summarizes the means, standard deviations, standard errors of measurement, and coefficient alphas for the instruments discussed above. The cognitive and affective variables measured by these instruments are the dependent variables for the study.

Administration of Instruments

All the pupil instruments described in the preceding section were administered by trained personnel from the Far West Laboratory for Educational Research and Development. Each staff member received a minimum of two hours of instruction in the use of proper testing procedures. During this training, the test administrators worked in pairs, reading instructions and actual tests aloud to insure consistency in examination procedures and to insure that pupils' reading ability interfered as little as possible in the measurement of their mathematics

TABLE 8

Paraprofessional Tutor Study

Summary of Psychometric Data for All Participating Pupils

Variables		Fourth Grade Pupils					Fifth Grade Pupils				
		N	Mean	S.D.	Alpha	SE Means	N	Mean	S.D.	Alpha	SE Means
Mathematics Achv't Concepts (ITBS) Items = 36 4th gr. 43 5th gr.	pre	162	13.0	7.3	.89	2.5	158	13.3	7.1	.85	2.7
	post	162	17.0	8.6	.92	2.5	158	17.1	7.8	.87	2.8
Mathematics Achv't Computation (CTBS) Items = 48	pre	162	18.9	9.8	.93	2.6	158	26.3	10.7	.93	2.7
	post	162	25.9	11.0	.94	2.6	158	28.1	11.4	.94	2.8
Academic Self-Concept Items = 28	pre	161	95.6	18.1	.88	6.3	156	95.8	19.4	.91	5.9
	post	157	94.4	20.8	.92	5.9	157	97.1	22.0	.94	5.5
Mathematics Self-Concept Items = 8	pre	161	24.7	6.7	.75	3.4	156	26.0	6.6	.77	3.2
	post	157	27.0	6.8	.79	3.1	157	28.0	7.1	.84	2.8
Attitude Toward Mathematics Items = 25	pre	161	50.5	10.1	.81	4.4	157	48.3	10.3	.84	4.1
	post	160	49.8	11.1	.86	4.2	154	48.1	10.1	.84	4.0
External Locus of Control Items = 9	pre	161	26.2	4.4	.64	2.6	156	27.0	4.9	.73	2.5
	post	160	27.6	4.3	.66	2.5	154	28.5	4.4	.69	2.4

performance, attitudes toward mathematics, self-concept, and locus of control.

All tests were group administered separately by grade level to the pupils selected for participation. The testing was conducted in each of the nine schools, the pretests between October 29 and November 9, 1973, and the posttests from May 18-29, 1974.

To prevent the sequence of the administration of tests from possibly contaminating the results, the tests were partially counterbalanced. The four resulting orders of test administration are shown in Table 9. Each group of pupils completed two of the four orders, one on each of two testing days. (The reader is reminded that the self-concept measure AbMy contained two self-concept subscales--academic and mathematics self-concept--and that the ATMS measured both attitude toward mathematics and external locus of control.) It should be noted that an attitude measure always was followed by a mathematics measure but that the reverse never occurred since it was felt that a pupil's performance on the mathematics measure might affect his attitude on a given day.

TABLE 9

Order of Test Administration

Order 1:	About Myself ITBS	Order 2:	Attitude Toward Math CTBS
Order 3:	About Myself CTBS	Order 4:	Attitude Toward Math ITBS

The test orders were alternated by grade level among the nine schools as illustrated in Table 10. One test administrator was scheduled into each school for both testing days. All participating pupils in a given school were tested at the same time, separately by grade level. Test administrators tested the same group of pupils on both testing days.

Time limitations were strictly observed in each testing session. Sessions that included the ITBS and an attitude measure were allowed 60 minutes--15 minutes for the attitude measure (the time required to read each item twice and allow pupils to record their responses) and 30 minutes for the ITBS (the time limit required by the test authors). The remaining 15 minutes were used for procedural activities such as reading instructions, answering questions, and passing out and collecting test booklets and answer sheets. For test sessions in which the CTBS was included, 70 minutes were required: 15 minutes for the attitude measure, 40 minutes for administration of the CTBS as required by its authors, and 15 minutes for procedural activities.

TABLE 10

Sample Testing Schedule

School	Grade Level	Testing Order* 1st Day	2nd Day
1	4th	4	3
	5th	2	1
2	4th	1	2
	5th	3	4

*Testing order numbers refer to the numbered test sequence in Table 9.

Tutor Variables

The tutor variables of interest in this study are those tutoring skills emphasized in Minicourse 5, the training vehicle, and certain additional tutor skills. These tutor variables are: (1) use of diagnostic questions, (2) use of prompting questions, (3) use of demonstration techniques, (4) use of verbal praise, (5) assignment of evaluation problems, (6) assignment of practice problems, (7) use of declarative statements, (8) use of constructive criticism, (9) use of recrimination, (10) existence of rapport, and (11) use of motivating statements. The first six variables are tutoring skills in which Minicourse 5 provides specific training (see Appendix A).

Use of Diagnostic Questions

As defined for purposes of this study with particular application in the tutorial setting, diagnostic questions were questions which tested the student's understanding of concepts and procedures necessary for the solution of particular problems. They might be phrased in either statement or question form. Five types of diagnostic questions were emphasized in the Minicourse 5 training: (1) general diagnostic questions, (2) questions that test the student's ability to read a problem, (3) questions that test the student's understanding of word definitions, (4) questions that test the student's understanding of number concepts, and (5) questions that ask the student to identify number operations appropriate to the solution of a given problem. Each instance of a diagnostic question used in a tutoring session was tallied on the Mathematics Tutoring Observation Form (MTOF)* by an observer. The instances of all

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*See page 52 for a complete description of the Mathematics Tutoring Observation Form.

five types of diagnostic questions were summed, and the variable, diagnostic questions, was derived by taking the mean number of diagnostic questions observed among all the tutoring sessions.

Use of Prompting Questions

Within the tutorial setting, prompting questions were defined as questions which encouraged a student to perform a particular number operation or to discover a procedure or solution to a problem. Questions which met this criterion and also could not be classified as one of the five types of diagnostic questions were tallied by the observer and recorded on the MTOF timeline. (See page 52 for a description of the timeline.)

Use of Demonstration Techniques

In this study, demonstration techniques were defined as those methods which a tutor used to develop student understanding of mathematical concepts and processes. Six demonstration techniques were examined: (1) estimation, (2) diagrams or pictures, (3) number sentences, (4) expanded notation, (5) number lines, and (6) manipulative materials.

As with the other tutor variables, to obtain a measure of tutor use of this skill, observations were made of actual tutoring sessions. (Details of the observation procedures are presented later in this report.) Each instance of the use of a demonstration technique was tallied by the observer. In addition to counting the number of demonstration techniques that were used during a tutoring session, the observer timed three of the six techniques: expanded notation, number line, and manipulative materials. As each of these techniques was used, the observer placed a checkmark on the timeline of the MTOF

at three-second intervals. Two variables were derived from these observations. The first represented the mean number of demonstration techniques for the total number of tutees of an individual tutor. The second represented the mean number of seconds spent using demonstration techniques for all the tutees of one tutor.

Use of Verbal Praise

Verbal praise was defined as being the oral rewarding of a student who had given the desired or correct response. Although general verbal praise and specific verbal praise were defined as separate skills in Minicourse 5, no distinctions were made in this study between the two types of praise. This decision was based on the results of the main field test of Minicourse 5 (Gall, 1973) which indicated that specific verbal praise was such an infrequent occurrence that it could not be analyzed as a separate skill. Instances of verbal praise were recorded by the observer as they occurred during the tutoring sessions, and the mean number of instances among the tutees of a single tutor was reported as the variable.

Assignment of Evaluation Problems

Minicourse 5 defines evaluation problems as those mathematical problems which are given to a tutored student to assess the student's understanding of number operations and mathematical processes. The student must solve the problem on his own during the tutoring sessions. If an evaluation problem was assigned to a student during the tutoring session, the observer noted this occurrence on the summary page of the MTOF.

Assignment of Practice Problems

Practice problems were defined for the purposes of this study as those mathematical problems which are given to a student to provide additional experience in demonstrating understanding of number operations and mathematical processes after the tutorial session has been completed. Any time that a tutor assigned problems which were to be completed at the student's seat or at home, the observer noted that practice problems had been assigned and recorded that information on the summary page of the MTOF.

Use of Declarative Statements

In this study, declarative statements were defined as tutor statements which provided the student with problem-solving information that the tutor might overwise have obtained from the student by asking him a question. In other words, a declarative statement was made when the tutor provided the answer for the student rather than attempting to elicit the answer from the student. The number of declarative statements made by the tutor was tallied by the observer and recorded on the MTOF timeline. The mean number of such statements, across the tutees of a single tutor, represented the variable.

Use of Constructive Criticism

Constructive criticism or correction was defined as the tutor's verbal response to student error, as long as that response contained no element of recrimination. Each instance of constructive criticism was recorded on the MTOF by the observer.

Use of Recrimination

Recrimination was defined as occurring when a tutor's criticism contained the clear implication that the student should have been doing something else, with a net effect of discouraging the student from further ventures (Flanders, 1970). Instances of recrimination were counted and recorded on the MTOF timeline by the observer.

Existence of Rapport

For purposes of this study, rapport or the tone of the tutoring session was defined in terms of the student's willingness to be cooperative and the tutor's ability to induce a relaxed, but productive, atmosphere. Rapport, which is recognized as a subjective variable, was rated on a 9-point scale with 1 indicating no rapport, 5 neutral, and 9 extremely good rapport.

Use of Motivating Statements

Motivating statements were defined as tutor statements at the conclusion of the tutoring session which were clearly intended to provide encouragement to the tutored student. These statements were noted by the observer on the summary page of the MTOF. The mean number of motivating statements made by each tutor, over the total number of students who were tutored by the individual, was used to represent the variable.

Tutor Instruments

Two tutor instruments were administered in the Math Tutoring Study--the Mathematics Tutoring Observation Form and the Mathematics Tutoring Questionnaire. Each is discussed below.

Mathematics Tutoring Observation Form

The Mathematics Tutoring Observation Form (MTOF) was used to record each occurrence of the tutoring skills and affective behaviors defined above. Tutor behavior was recorded at three-second intervals on an adaptation of the timeline used in the Flanders Interaction Analysis Coding System (Flanders, 1970). The MTOF and MTOF Summary Sheet are reproduced in Table 11.

On the upper portion of the MTOF, the observer noted the starting and ending time of the tutoring session, the paraprofessional's name, the name of the student receiving tutoring, the observer's name, and the date on which the observations took place. In addition, the observer noted whether the student was receiving tutoring on verbal reasoning problems (abbreviated to VR on the MTOF) or number operation problems (NO).

Each square on the timeline of the MTOF represented 3 seconds. The observer placed a check mark or number in the appropriate box as interaction between tutor and student took place. On the first line of the MTOF timeline, each instance of a tutor declarative (abbreviated TD) was indicated by a check mark placed at three-second intervals. In this case, as in others in which the number of instances rather than time was being counted, a series of check marks equaled one instance of the behavior. The second line of the MTOF timeline was used to indicate tutor response (TR) to student questions. Again, the same procedure was used for counting instances.

On the third line of the MTOF timeline, tutor questions (TQ) were indicated by placing the number of the appropriate question type in a box. (The types of questions were numbered according to their presentation on pages 47-48.) The next two lines of the MTOF timeline were used

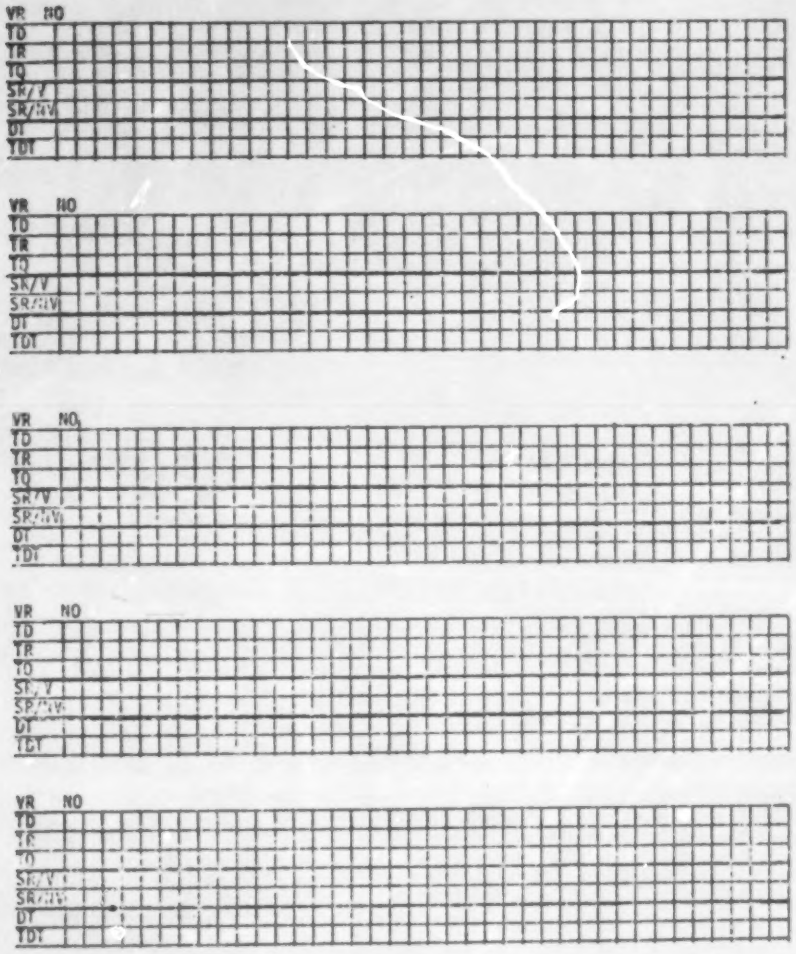
TABLE 11

The Mathematics Tutoring Observation Form and Summary Sheet

MTOF Starting Time _____ Ending Time _____

Teacher_____ Student_____

Observer_____ Date_____



Interruptions_____

Evaluation? YES NO Practice Problems YES NO

Motivating Statement? YES NO Warmth/Rapport 1 2 3 4 5 6 7 8 9

MTOF Summary Sheet

Teacher_____ Date_____

Student_____ Observer_____

Problem_____ NO VR

Evaluation?____ Practice Problems?____ Motivating Statement?____

Warmth/Rapport____ Interruptions_____

QUESTIONS

Total____

Type 1_____

Type 2_____

Type 3_____

Type 4_____

Type 5_____

Type 6_____

DEMONSTRATION TECHNIQUES

Instances of:

Estimation____

Diagrams/Pictures____

Number Sentences____

Expanded Notation____

Manipulatives____

Total Seconds

_____

_____

_____

COMMENTS:_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

to record student responses. Student verbal responses were coded on the Student Response/Verbal (SR/V) line of the timeline and student nonverbal responses were coded on the Student Response/Nonverbal (SR/NV) line. On the last two lines of the timeline, instances of untimed demonstration techniques (DT) and timed demonstration techniques (TDT) were recorded.

At the bottom of each timeline, the observer was required to indicate the number of interruptions which took place during the tutoring session, whether or not evaluation and practice problems had been assigned, and whether a motivating statement had been made, and to rate the warmth or rapport of the tutoring session on a scale from 1 (low rapport) to 9 (high rapport).

Before coding sheets were handed in to the coordinator, all data from individual sheets were summarized on the MTOF Summary Sheet. Space also was available under "comments" to list any unusual occurrences during the tutoring session.

Mathematics Tutoring Questionnaire

Through the use of the Mathematics Tutoring Questionnaire (MTQ), a measure of tutor knowledge and application of tutoring skills was obtained. The MTQ contained 32 controlled stimulus situations which presented specific mathematics problems followed by at least one question about the situation and a blank space for recording the response. The mathematics problems used in the instrument were based on examples from fourth and fifth grade mathematics textbooks.

The MTQ was developed by the Far West Laboratory's Math Tutoring Study team to assess tutors' acquisition of knowledge about the skills

taught in Minicourse 5. As part of the development process, the questionnaire was administered to selected staff members of the Far West Laboratory. The results of this "quick and dirty" pilot test indicated that the questionnaire discriminated between those staff members who were familiar with the skills taught in Minicourse 5 and those who were not. In a more formal pilot test, the questionnaire was given to 12 teachers from Los Angeles County who had taken Minicourse 5 as part of the county's inservice teacher training program during the previous year. Twelve teachers who had not taken the Minicourse also were given the questionnaire. The findings of this field test corroborated those of the earlier test in that the MTQ discriminated between those teachers who had taken Minicourse 5 and those who had not.

The MTQ yielded a total score and 7 subscale scores. The subscales were: (1) tutoring, (2) basic tutoring sequence, (3) asking diagnostic questions, (4) using demonstration techniques, (5) assigning practice problems, (6) assigning evaluation problems, and (7) providing verbal praise. The means and standard deviations for the tutor sample are reported in Table 12.

Observer Training and Data Collection Procedures

The Mathematics Tutoring Observation Form (MTOF) was employed to collect data on the use of certain tutoring skills and affective behaviors by tutors. To assure that data were collected in a consistent and reliable manner, observers were hired and trained to use the MTOF.

Originally four persons, all college undergraduates, were hired as observers. They each received approximately sixteen hours of training at the Far West Laboratory during February, 1974.

TABLE 12

Means and Standard Deviations for the Mathematics Tutoring Questionnaire by Treatment

	Mini 5 Trained Tutors n = 6		Regular Tutors n = 10	
	Mean	SD	Mean	SD
Tutoring	2.9	1.24	2.4	1.45
Tutoring Sequence	1.4	1.3	0.5	0.72
Diagnostic Questions	6.2	3.5	2.5	1.66
Demonstration Techniques	5.9	3.70	4.2	1.75
Practice Problems	1.9	1.59	0.9	1.13
Evaluation Problems	0.6	0.81	1.2	1.52
Verbal Praise	2.3	1.08	1.1	1.30
Total Scale	21.4	8.91	12.9	3.81

Training was conducted by a member of the Laboratory's staff using materials adapted from those employed to train observers for the Minicourse 5 field tests. Observers read the Observer Manual (See Appendix F), discussed the tutor skills, and viewed two of the Minicourse 5 training films. They then coded training videotapes prepared by the staff of the Math Tutoring Study and, after discrepancies in coding were discussed, recoded the training tapes. Reliability information was collected from observers by having them code, without discussion, three reliability videotapes of tutoring sessions.

After observer training had been completed but before observation had begun, as previously discussed, the schools were closed by the strike. As a result, all four observers were unable to continue with the study when it resumed. The observer trainer, a member of the Far West Laboratory's staff, therefore performed the tutor observations for the study. This individual had not been involved in the recruitment or selection of tutors, had not made on-site arrangements, and had not participated in assigning tutors to treatment conditions or students to tutors. Consequently she was considered to be a fair, impartial observer for the purposes of the study. Because she was an observer trained and skilled in the use of the Mathematics Tutoring Observation Form, the observation data collected for this study are probably more reliable than would otherwise have been obtained. Naturally, however, there are no inter-rater reliability data for this study.

The original observation schedule called for each tutor to be observed with each of his tutees during a minimum of three sessions. With only one observer, it was impossible to adhere to this plan.

Table 13 records the number of observations that were made. All except five paraprofessional tutors were observed at least twice. In each instance, the observer was present throughout the entire tutoring session. While this final number of observations was less than would have been desired, they are considered adequate to serve as an indicator of the treatment conditions that were present.

Tutor Training

Two types of tutor training were provided. All tutors first received training in mathematical skills and concepts and then approximately half the tutors received training in tutoring skills through Minicourse 5.

The purpose of the mathematics training was to familiarize the paraprofessionals with the mathematical skills and concepts taught in the fourth and fifth grades. The tutors were given a diagnostic test composed of items selected from the mathematics textbooks used at these grade levels in the participating schools. Based on the results of this test, the following topics were covered during training: (1) sets, numbers, and numerations; (2) sentences and problem solving; (3) measurements; (4) operations and properties; (5) geometry; (6) relations and functions; and (7) probability, statistics, and graphing. Training sessions were held at the Far West Laboratory two hours a day for ten days with a Laboratory staff member and a mathematics resource teacher from the school district serving as instructors.

Half the paraprofessionals then received training in mathematics tutoring skills. Minicourse 5: Individualizing Instruction in Mathematics (described in Appendix A) was used in shortened form for this purpose. The tutors read the course handbook, viewed the course films,

TABLE 13

Paraprofessional Tutor Study

Number of Observations Per Tutor

School	Mini 5 Tutor			Regular Tutor		
	Tutor 1	Tutor 2	Tutor 3	Tutor 1	Tutor 2	Tutor 3
1	2	2	- *	-	2	-
2	2	2	3	0	-	0
3	2	0	2	2	3	-
4	-	2	-	-	2	3
5	2	-	-	2	4	-
6	3	2	-	1	0	-
7	-	2	-	2	-	-
8	2	4	-	5	-	-
9	2	-	-	2	2	-

*A dash indicates that there was no tutor in that particular cell

and discussed the tutoring skills in group meetings held at the Laboratory. Microteaching lessons were taught at a nearby private school, with the paraprofessionals videotaping the sessions and evaluating their own performance as tutors. In total, the tutoring training program involved approximately two and one-half hours of work per day for nine days.

Following the interruption of the study by the strike, all tutors were given a half-day refresher course before they resumed tutoring.

Tutor Use of Skills

In order to investigate tutor use of skills, a discriminant analysis was performed on twelve tutor variables consisting of observed tutor skills and interpersonal behaviors. Scores on these variables were available for 15 Minicourse 5 trained tutors and 13 mathematics trained tutors. Scores for each tutor were obtained by averaging over observations. The number of times each tutor was observed ranged from 1 to 5.

The 12 tutor variables were used in a discriminant analysis for the two groups of tutors. The discriminant function was not significant (Wilk's Lambda = .51, and Rao's F ratio approximation = 1.28 with 12 and 16 degrees of freedom). Thus, there is no good basis for distinguishing between Minicourse 5 and mathematics only trained tutors in terms of the 12 tutor variables used in this study.

The group means and standard deviations are reported in Table 14, and the intercorrelations of the tutor variables for the total group of 29 tutors are reported in Table 15. Six pairs of variables in Table 15 correlate .50 or greater: (1) demonstration frequency with demonstration time, (2) praise with rapport, (3) diagnostic questions

with constructive criticism, (4) prompting with declarative statements, (5) prompting with praise, and (6) evaluation problems with motivating statements.

TABLE 14

Means and Standard Deviations of Observation Variables for Tutors

Observation Variable	Minicourse 5 + Mathematics Trained Tutors (N = 16)		Mathematics Only Trained Tutors (N = 13)	
	Mean	SD	Mean	SD
Diagnostic Question	6.5	5.5	4.1	4.3
Prompting	35.6	14.8	36.8	15.6
Evaluation Problem	.7	.5	.4	.5
Practice Problem	.2	.4	.2	.4
Demonstration Technique (time)	2.4	9.5	.0	.0
Demonstration Technique (frequency)	.4	.8	.4	.6
Praise	20.2	9.4	15.8	14.4
Rapport	6.2	.9	5.8	1.1
Motivating Statement	.8	.4	.4	.5
Declarative Statement	19.4	8.4	24.0	8.1
Criticism	4.5	4.5	5.0	2.9
Recrimination	.2	.4	.9	1.3

TABLE 15

Intercorrelations of Observation Variables for Total Group of Tutors

(N = 29) (Decimal Points Omitted)

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1 Diagnostic Question	100											
2 Prompting	10	100										
3 Evaluation Problem	-05	11	100									
4 Practice Problem	-06	-35	12	100								
5 Demonstration Technique (time)	25	23	-21	-10	100							
6 Demonstration Technique (frequency)	26	45	-20	-15	69	100						
7 Praise	16	54	34	14	09	00	100					
8 Rapport	39	02	32	25	-01	-07	56	100				
9 Motivating Statement	33	-04	51	-09	16	16	-04	18	100			
10 Declarative Statement	-13	60	00	-45	06	10	15	-26	-03	100		
11 Criticism	57	07	-05	04	01	-08	37	26	-10	-03	100	
12 Recrimination	-11	18	-16	-10	-10	02	07	-39	-13	07	31	100

SECTION THREE

RESULTS

CHAPTER V

GENERAL EFFECTS OF TUTORING

Four specific research questions were asked in the study. They were:

1. Are there differential effects from systematic mathematics tutoring associated with the initial ability level of tutored pupils on a set of dependent variables?

2. Do pupils who receive systematic mathematics tutoring from tutors trained in tutorial skills perform better on a set of dependent variables than pupils of comparable ability who receive systematic mathematics tutoring from tutors who have not had mathematics tutoring training?

3. Do pupils who receive systematic mathematics tutoring perform better on a set of dependent variables than pupils of comparable ability who receive no systematic mathematics tutoring?

4. Are there particular combinations of tutoring skills or interpersonal behaviors which are positively related to specific pupil outcomes?

A number of analyses were completed in order to answer these questions:

- One-way analysis of variance with four blocks based on pupils' entry level ability on each of the dependent measures was performed to answer Questions 1 through 3.

- Deviation regression analyses were conducted to provide preliminary information concerning the relationship of tutor skills to pupil outcomes (Question 4).

- Communality regression analyses were performed to provide more thorough investigations of the relationships of particular clusters of tutor skills and interpersonal behaviors to pupil outcomes.

The results of these analyses are presented by reporting the general effects of tutoring on mathematics achievement and pupil attitudes in this chapter, and the relationships of tutoring skills to pupil outcomes in Chapter VI.

Information relative to the first three research questions (concerned with effects which could be attributed to differential ability of pupils, tutor training, and tutoring itself) was obtained through analyses of variance. The original design of the study called for the use of two ability levels in these analyses, pupils who were above and pupils who were below median in mathematics achievement. Because of the differences among the medians for the various schools (see Table 7), it was decided to modify the original plan and create four pupil ability blocks for each dependent variable.

The four pupil ability blocks were established by dividing the sample of participating pupils at the pre mean, separately for each dependent variable and for each grade level. Pupils one standard deviation below the mean were assigned to block 2, and pupils one standard deviation above the mean to block 3. The remaining pupils above the mean were assigned to block 4; the remaining pupils below the mean were assigned to block 1. The resulting schema is illustrated in Table 16.

TABLE 16

Schema: Block by Treatment Analysis of Variance

Ability Level	Minicourse 5 + Mathematics Trained Tutors	Mathematics Only Trained Tutors	Control Group (No Tutors)
Block 4 (High)			
Block 3			
Block 2			
Block 1 (Low)			

The mathematical model for this design is represented by the equation

$$y = \mu + T_i + B_j + TB_{ij} + \in .$$

That is, an observed post measure (y) is a function of the overall mean for the post measure (μ), a treatment effect (T), an effect due to block (B), a block by treatment interaction (TB), and error ($\in$).

After standard manipulation of the model (here performed by BMDP2V, a two-variable analysis of variance program) the means were tested for statistical difference under the null hypothesis of no effect due to treatment. A block effect was expected in each analysis, as the blocks were constructed to differentiate among differing levels of ability. The subjects in each block and treatment were drawn from classrooms in several different schools, although the assignment to tutors within a given school was without particular regard to pupils classroom assignments.

In addition to the analysis of variance results, a Relative Efficiency Coefficient (Myers , 1972) was computed for each dependent variable at both grade levels to determine the relative power of the four block analysis of variance design as compared with traditional analysis of covariance. A relative efficiency coefficient of 1.00 would indicate that the two analyses were equal in power. In these analyses, a coefficient of less than 1.00 indicates that the block design has more power, while a coefficient larger than 1.00 indicates that the analysis of covariance has more power. The Relative Efficiency Coefficients ranged from a low of 0.99 (fifth grade Attitude Toward Mathematics) to a high of 1.15 (fifth grade ITBS), indicating that in the case of the fifth grade attitude toward mathematics analysis, the block design

provided a more powerful analysis than analysis of covariance. For all other analyses, while some power was lost by using a block design rather than the analysis of covariance design, the loss of power was minimal. All relative efficiency coefficients are displayed by grade and dependent variable in Table 17.

TABLE 17

Paraprofessional Tutor Study

Relative Efficiency Coefficients
by Dependent Variable and Grade

Variable	Grade 4	Grade 5
Mathematics Computation (CTBS)	1.01	1.09
Mathematics Concepts (ITBS)	1.04	1.15
Attitude Toward Mathematics	1.07	0.99
Academic Self-Concept	1.04	1.00
Mathematics Self-Concept	1.11	1.12
External Locus of Control	1.07	1.06

Mathematics Achievement Results

As noted earlier, the treatment effects on two separate mathematics abilities were investigated. Computational skill was assessed by the computation section of the Comprehensive Tests of Basic Skills, Form Q, Level 2 (CTBS, 1968). Understanding of mathematical concepts was measured by the Modern Mathematics Supplement to the Iowa Tests of Basic Skills (ITBS, Lindquist, et al., 1968).*

Computational Skills--CTBS

The analysis of variance results for the CTBS are presented in Tables 18 and 19 for fourth and fifth grade pupils, respectively. In these and all subsequent tables, a probability given as 0.00 is an actual probability of less than 0.0001. An inspection of the findings indicates that most of the variance could be accounted for by the blocks (fourth grade F = 24.63 with an associated probability of less than 0.0001). No other F ratios approached conventional levels of significance. There were no effects which could be attributed to either the treatments or the block by treatment interaction.

Understanding of Concepts--ITBS

The fourth and fifth grade analysis of variance results for the ITBS are presented in Tables 20 and 21.

Initial ability in understanding mathematics concepts, as represented by the blocks, accounted for the majority of the variance at both grade levels. Neither the treatments nor the treatment by block interactions

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* All analyses were performed for pupils with pre and post measures present for a given dependent variable.

TABLE 18

Analysis of Variance

Computational Skills (CTBS) - Grade 4

Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	78900.0	1	78900.00	1060.70	0.00
Treatment	50.5	2	25.23	0.34	0.71
Block	5497.01	3	1832.34	24.63	0.00
Treatment by Block	607.78	6	101.30	1.36	0.23
Error	10860.14	146	74.38		

	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block
Ability Level	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	Mean
Block 4 (high)	38.8	3.49	5	37.4	6.55	7	37.2	7.50	15	37.55
Block 3	27.3	9.26	10	29.7	10.79	10	30.1	9.25	21	29.32
Block 2	25.2	10.59	26	24.9	8.56	15	19.7	7.23	29	22.86
Block 1 (low)	19.4	8.35	5	11.8	5.07	5	18.4	7.89	10	17.00
Method Mean	26.50			26.79			25.94			

TABLE 19

Analysis of Variance

Computational Skills (CTBS) - Grade 5

Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	112512.56	1	112512.56	1956.52	0.00
Treatment	132.87	2	66.44	1.16	0.32
Block	7658.84	3	2552.95	44.39	0.00
Treatment by Block	185.71	6	30.95	0.54	0.78
Error	8165.91	142	57.51		

Ability Level	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block Mean
	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	
Block 4 (high)	39.3	2.94	6	40.8	4.81	11	39.8	4.71	14	40.06
Block 3	34.7	7.32	15	30.6	10.13	10	31.5	9.37	20	32.37
Block 2	26.7	8.75	15	26.2	8.58	14	22.0	7.47	22	24.54
Block 1 (low)	19.8	6.51	10	17.0	5.04	8	17.7	7.92	9	18.27
Method Mean	29.45			29.25			28.16			

TABLE 20

Analysis of Variance

Mathematical Concepts (ITBS) - Grade 4

Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	37893.91	1	37893.91	1202.38	0.00
Treatment	64.45	2	32.22	1.02	0.36
Block	4538.04	3	1512.68	48.00	0.00
Treatment by Block	214.37	6	35.73	1.13	0.35
Error	4412.23	140	31.52		

Ability Level	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block Mean
	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	
Block 4 (high)	30.1	2.48	7	26.4	5.59	7	28.8	6.63	12	28.50
Block 3	23.8	4.02	5	19.7	4.42	9	21.7	5.98	18	21.47
Block 2	13.0	4.54	27	15.7	5.91	15	14.3	6.60	32	14.11
Block 1 (low)	11.7	6.31	6	10.0	6.68	4	14.1	4.28	10	12.56
Method Mean	16.69			18.22			18.54			

TABLE 21

Analysis of Variance

Mathematical Concepts (ITBS) - Grade 5

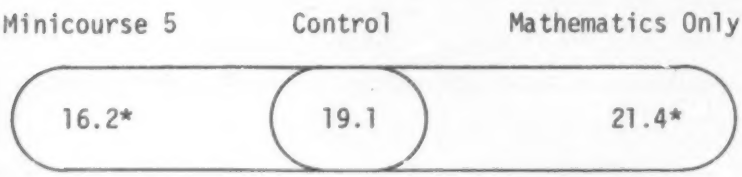
Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	37914.98	1	37914.98	1323.26	0.00
Treatment	97.70	2	48.85	1.70	0.19
Block	3792.90	3	1264.30	44.12	0.00
Treatment by Block	269.21	6	44.87	1.57	0.16
Error	4068.30	142	28.65		

Ability Level	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block Mean
	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	
Block 4 (high)	25.3	5.56	4	30.7	4.64	9	28.3	5.46	11	28.70
Block 3	16.2	7.19	17	21.4	5.16	12	19.1	5.94	14	18.60
Block 2	15.5	5.29	17	13.1	4.70	15	14.8	5.42	33	14.59
Block 1 (low)	9.8	2.32	6	11.0	4.21	8	11.5	3.38	8	10.85
Method Mean	15.88			18.56			17.56			

received F ratios that approached traditional levels of significance at either grade level. Even though the overall F ratio for treatment was not statistically significant, the Studentized Newman-Keuls Test was performed for each block. For block 3 (the second highest ability level) at the fifth grade level, two sets of homogeneous means consisting of two means each were detected by the Newman-Keuls test, indicating that the pupils of mathematics only trained tutors scored signuficantly higher on the ITBS than did pupils of Minicourse 5 trained tutors ($p = 0.05$). Neither group, however, was significantly different from the control pupils. These results are illustrated in Figure 2.

FIGURE 2

Studentized Newman-Keuls Results
ITBS; Block 3: Grade 5



*Pair of means significantly different at the 0.05 level

Pupil Attitude Results

Pupil attitudes were examined in four areas: attitude toward mathematics, academic self-concept, mathematics self-concept, and external locus of control. The results of these analyses are presented below.

Attitude Toward Mathematics

The analysis of variance results for the fourth and fifth grade attitude toward mathematics scale are presented in Tables 22 and 23.

Most of the variance on the attitude toward mathematics scale was accounted for by the initial attitude of the pupils as represented by the blocks. For fourth grade pupils, the F ratios for treatment and for the treatment by block interaction failed to approach conventional levels of significance. For fifth grade pupils, while the treatment F ratio was statistically nonsignificant, the treatment by block interaction received an F ratio of 2.14 with an associated probability of 0.05. This interaction is illustrated in Figure 3.

An examination of Figure 3 shows that among Block 1 pupils (the pupils whose attitude toward mathematics was lowest on these measures), those who were tutored by mathematics only trained tutors scored considerably lower on the post attitude toward mathematics measure than pupils of Minicourse 5 trained tutors and the control pupils. In each of the other three blocks, the post scores on the attitude toward mathematics scale were similar across treatments. Pupils in the first block, then, were primarily responsible for the significant treatment by block interaction.

TABLE 22

Analysis of Variance

Attitude Toward Mathematics - Grade 4

Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	317193.00	1	317193.00	4228.09	0.00
Treatment	34.35	2	17.17	0.23	0.80
Block	7858.56	3	2619.52	34.92	0.00
Treatment by Block	378.98	6	63.16	0.84	0.54
Error	11028.00	147	75.02		

Ability Level	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block Mean
	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	
Block 4 (high)	36.5*	9.50	6	38.0	8.23	8	41.1	8.24	14	39.23
Block 3	46.4	9.64	18	48.4	8.74	11	46.3	6.55	25	46.76
Block 2	53.8	11.41	17	53.8	9.09	10	51.8	6.90	28	52.78
Block 1 (low)	65.4	11.30	7	58.9	5.87	7	64.8	10.44	8	63.11
Method Mean	50.55			49.63			49.36			

* For this variable, a lower score indicates a higher or more positive attitude toward mathematics.

TABLE 23

Analysis of Variance

Attitude Toward Mathematics - Grade 5

Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	290143.44	1	290143.44	3958.11	0.00
Treatment	41.25	2	20.62	0.28	0.76
Block	3984.74	3	1328.25	18.12	0.00
Treatment by Block	941.14	6	156.86	2.14	0.05
Error	10335.80	141	73.30		

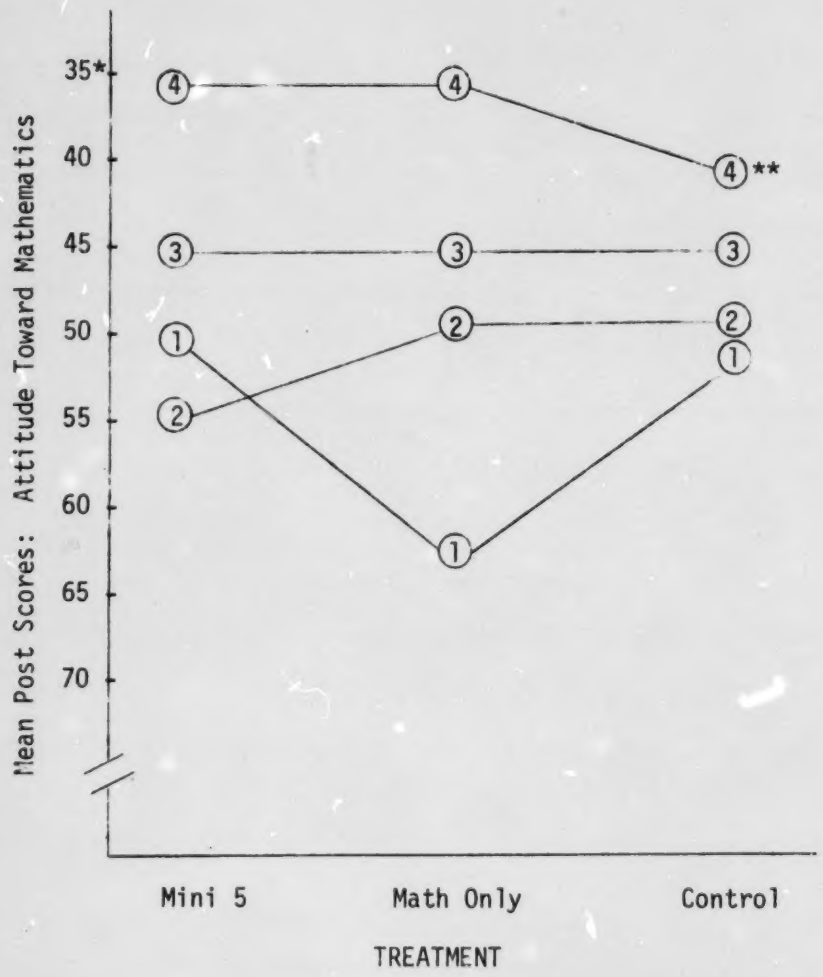
Ability Level	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block Mean
	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	
Block 4 (High)	37.8*	6.25	12	37.8	7.78	6	43.6	11.76	14	40.34
Block 3	45.1	6.88	15	45.3	8.88	13	45.8	9.86	17	45.42
Block 2	54.4	8.11	14	50.7	9.55	15	50.5	7.05	20	51.68
Block 1 (low)	52.0	7.12	4	61.4	6.86	9	51.8	8.93	14	55.03
Method Mean	46.66			49.51			48.06			

* For this variable, a lower score indicates a higher or more positive attitude toward mathematics.

FIGURE 3

Treatment By Block Interaction

Attitude Toward Mathematics: Grade 5



*For this variable, a lower score indicates a higher or more positive attitude toward mathematics.

**Numerals represent blocks to which students were assigned.

Academic Self-Concept

The results of the analysis of variance of academic self-concept for grades four and five are presented in Tables 24 and 25.

An examination of Tables 24 and 25 shows that the F ratios for treatment failed to reach conventional levels of significance at both grade levels. As could be expected, the majority of the variance was accounted for by the pupils' initial level on the academic self-concept measure. On this measure, however, the treatment by block interaction reached conventional levels of significance with an F of 1.88 and an associated probability of 0.09 for fourth grade pupils, and an F of 2.53 with an associated probability of 0.02 for fifth grade pupils. These interactions are graphically presented in Figures 4 and 5.

In Figure 4, the interaction may be explained by noting that in blocks 1 and 2, pupils of Minicourse 5 tutors had higher mean post scores on the academic self-concept measure than pupils in the other two treatment conditions; the reverse was true in blocks 3 and 4 where the pupils of Minicourse 5 trained tutors scored lowest. For fifth grade pupils, Figure 5 shows that in each of blocks 1 and 3, pupils of the math only trained tutors received the lowest mean post scores. However, this effect did not hold in blocks 2 and 4 where the pupils of mathematics only trained tutors had the highest mean post scores.

Although the overall treatment effect was statically nonsignificant, the Studentized Newman-Keuls test was performed across the treatments, separately for each block. At grade four, two sets of homogeneous means, each containing two means, were detected in block 3. This result indicates that, at the 0.05 level of significance, the mean scores of

TABLE 24

Analysis of Variance

Academic Self-Concept - Grade 4

Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	1034310.25	1	1034310.25	3505.99	0.00
Treatment	331.21	2	165.61	0.56	0.57
Block	20118.17	3	6706.05	22.73	0.00
Treatment by Block	3332.62	6	555.44	1.88	0.09
Error	42481.79	144	295.01		

Ability Level	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block Mean
	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	
Block 4 (high)	113.8	32.50	8	118.2	21.64	4	117.6	12.40	9	116.27
Block 3	91.8	21.41	13	111.1	14.44	8	100.1	15.68	33	99.73
Block 2	92.6	13.75	19	87.0	11.68	16	88.1	17.26	23	89.27
Block 1 (low)	85.6	18.65	7	73.7	11.93	7	68.1	18.31	9	75.13
Method Mean	94.95			93.41			94.61			

TABLE 25

Analysis of Variance

Academic Self-Concept - Grade 5

Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	1046506.25	1	1046506.25	4467.34	0.00
Treatment	144.57	2	72.28	0.31	0.74
Block	35908.91	3	11969.64	51.10	0.00
Treatment by Block	3554.72	6	592.45	2.53	0.02
Error	33498.77	143	234.26		

	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block
Ability Level	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	Mean
Block 4 (high)	117.9	13.04	10	120.8	19.48	4	111.7	17.35	11	115.64
Block 3	113.5	9.34	8	102.7	17.79	18	108.5	13.57	27	107.28
Block 2	82.7	12.51	19	96.5	16.47	17	96.2	17.02	17	91.46
Block 1 (low)	67.0	16.21	7	57.4	16.21	5	71.3	15.44	12	67.15
Method Mean	98.80			96.80			99.24			

FIGURE 4

Treatment By Block Interaction

Academic Self-Concept: Grade 4

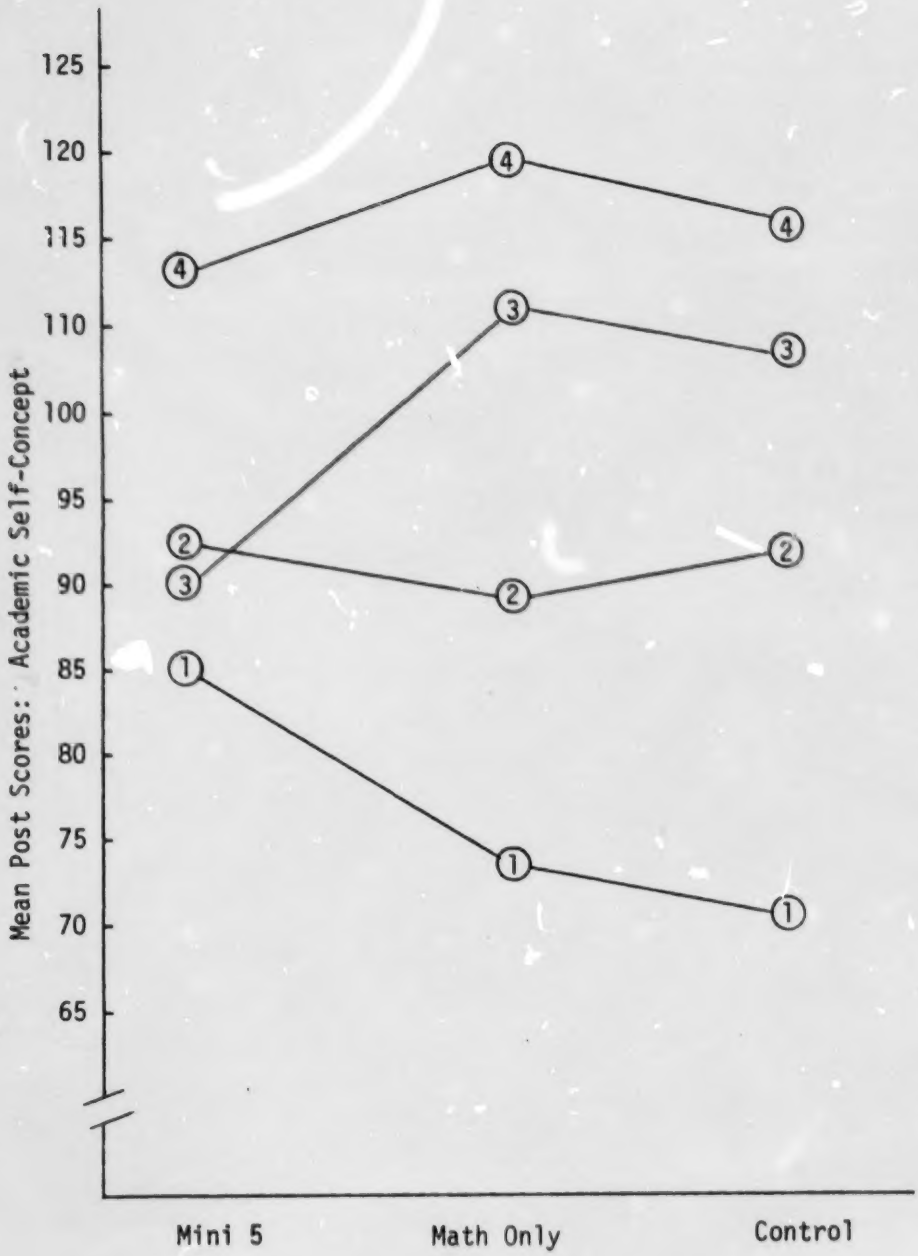
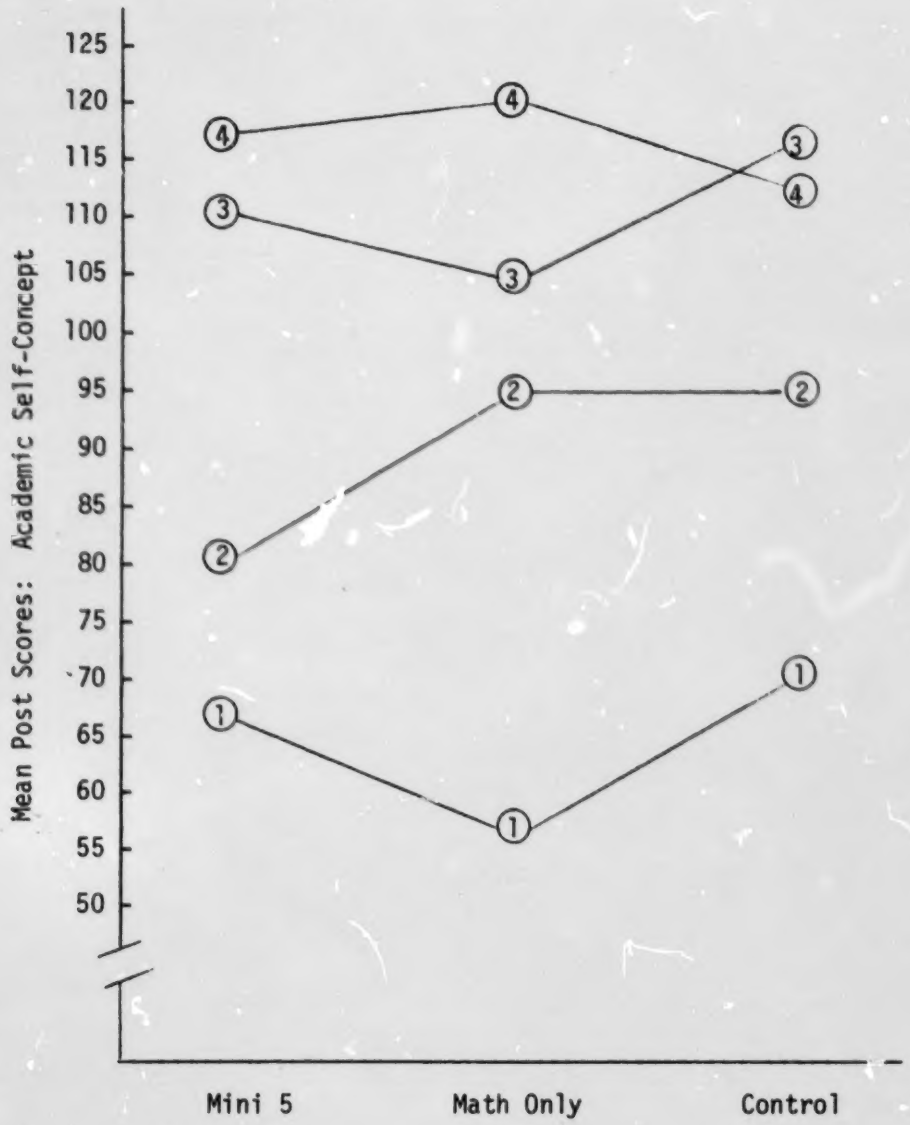


FIGURE 5

Treatment by Block Interaction

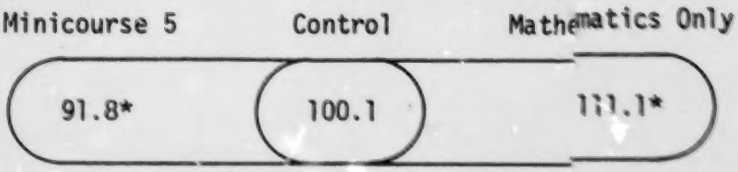
Academic Self-Concept: Grade 5



the mathematics only treatment were significantly higher than those of the Minicourse 5 treatment. However, the mean of neither group was significantly different from that of the control group. These results are illustrated in Figure 6.

FIGURE 6

Studentized Newman-Keuls Results
Academic Self-Concept; Block 3: Grade 4



*Pair of means significantly different at 0.05 level.

When the Studentized Newman-Keuls test was applied to the means of the fifth grade pupils on the academic self-concept measure, differences which were significant at the 0.05 level were detected in block 2. The pupils of Minicourse 5 tutors scored significantly lower than both the mathematics only and control treatment pupils. There were no significant differences between the latter groups. These results are illustrated in Figure 7.

Mathematics Self-Concept

The fourth and fifth grade analyses of variance for the mathematics self-concept measures are reported in Tables 26 and 27.

TABLE 26

Analysis of Variance

Mathematics Self-Concept - Grade 4

Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	80444.06	1	80444.06	2452.06	0.00
Treatment	46.92	2	23.46	0.72	0.49
Block	1967.61	3	655.87	19.99	0.00
Treatment by Block	75.16	6	12.53	0.38	0.89
Error	4724.17	144	32.81		

Ability Level	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block Mean
	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	
Block 4 (high)	32.9	6.90	8	36.0	3.56	4	32.2	4.29	15	32.97
Block 3	28.4	6.31	16	29.4	3.95	10	28.8	5.62	24	28.79
Block 2	25.5	5.59	19	24.9	5.54	15	24.6	5.77	24	24.97
Block 1 (low)	23.0	10.80	4	19.9	4.89	6	19.5	6.34	11	20.28
Method Mean	27.53			26.60			26.74			

TABLE 27

Analysis of Variance

Mathematics Self-Concept - Grade 5

Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	100112.50	1	100112.50	3114.97	0.00
Treatment	21.53	2	10.76	0.33	0.72
Block	2919.63	3	973.21	30.28	0.00
Treatment by Block	95.81	6	15.97	0.50	0.81
Error	4595.91	143	32.14		

Ability Level	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block Mean
	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	
Block 4 (high)	35.3	3.01	8	36.2	4.22	6	34.9	3.84	10	35.36
Block 3	31.8	5.25	10	30.3	3.90	20	28.8	5.78	24	29.91
Block 2	27.3	5.65	16	28.3	5.09	7	25.7	6.87	26	26.59
Block 1 (low)	19.7	6.24	10	20.6	7.85	11	22.1	6.15	7	20.65
Method Mean	28.05			28.36			27.81			

FIGURE 7

Studentized Newman-Keuls Results
Academic Self-Concept; Block 2: Grade 5

Minicourse 5	Mathematics Only	Control
82.7**	96.2	96.5

**This mean significantly different than both other means at the 0.05 level.

The results for the fourth and fifth grade pupils were similar. At both grade levels, the F ratio for blocks was significant, indicating that most of the variance was accounted for by the pupils' initial level of mathematics self-concept. No other F ratios were significant. No effects due to treatment or treatment by block interactions were detected.

External Locus of Control

The results of the analysis of variance of external locus of control for grades four and five are presented in Tables 28 and 29.

An inspection of Tables 28 and 29 shows that the pupils' initial level of external locus of control accounted for the greatest amount of variance on the post measure. No other F ratios approached conventional levels of significance in the fourth grade analysis. For fifth grade pupils, however, an F ratio of 2.60 with an associated probability of 0.08 was obtained for treatment, indicating that there were differences among the overall treatment means which could be considered significant.

TABLE 28

Analysis of Variance

External Locus of Control - Grade 4

Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	72404.06	1	72404.06	5121.48	0.00
Treatment	12.40	2	6.20	0.44	0.65
Block	759.95	3	253.32	17.92	0.00
Treatment by Block	51.30	6	8.55	0.60	0.73
Error	2078.19	147	14.14		

	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block
Ability Level	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	Mean
Block 4 (high)	30.3	4.40	8	32.3	2.80	6	30.8	4.43	12	30.99
Block 3	29.8	3.36	12	29.1	4.16	8	29.0	3.28	25	29.23
Block 2	25.7	3.60	20	25.6	3.50	20	26.7	3.81	30	26.10
Block 1 (low)	23.6	1.60	8	22.0	5.66	2	25.3	5.78	8	24.18
Method Mean	27.14			27.29			27.9[illegible]			

TABLE 29

Analysis of Variance

External Locus of Control - Grade 5

Source	Sum of Squares	DF	Mean Square	F ratio	F Prob
Mean	99077.19	1	99077.19	7631.44	0.00
Treatment	67.56	2	33.78	2.60	0.08
Block	944.37	3	314.79	24.25	0.00
Treatment by Block	63.05	6	10.51	0.81	0.56
Error	1817.59	140	12.98		

	Minicourse 5 & Mathematics Trained Tutors n = 16			Mathematics Only Trained Tutors n = 15			Control Group (No Tutors)			Block
Ability Level	Post Mean	SD	n	Post Mean	SD	n	Post Mean	SD	n	Mean
Block 4 (high)	33.6	2.37	7	32.1	5.24	7	31.5	3.84	13	32.20
Block 3	30.1	3.94	24	31.0	3.30	13	28.4	3.22	28	29.55
Block 2	24.9	3.27	8	28.0	3.81	13	25.5	3.75	14	26.29
Block 1 (low)	25.8	3.19	6	25.0	3.12	9	24.3	3.53	10	24.91
Method Mean	29.1			29.0			27.8			

This difference is accounted for by the fact that the means of both tutoring groups (29.1 for the pupils of Minicourse 5 trained tutors and 29.0 for the pupils of math only trained tutors) were higher than the mean of the control pupils (27.8). The F ratio for the fifth grade treatment by block interaction did not reach traditional levels of significance.

Summary of Results

A summary of the fourth grade analysis of variance results is presented in Table 30.

An examination of Table 30 shows that there were no F ratios in the fourth grade analyses which approached conventional levels of significance for treatment on any of the six dependent variables. That is, there were no effects of tutoring which could be attributed to treatment. However, for each dependent variable, the initial ability level of the pupils, as represented by the blocks, remained significant on the post measures as indicated by the significant F ratios which had probabilities of Type I error of less than 0.0001. Academic self-concept was the only variable on which a treatment by block interaction was detected ($F = 1.88$, $p = 0.09$) which approached a conventional level of significance. All other treatment by block interactions were statistically nonsignificant.

A summary of the fifth grade analyses of variance results is presented in Table 31.

Table 31 shows that there were few differences between the fourth and fifth grade analysis of variance results. In the fifth grade analyses, only the external locus of control measure received an F ratio for treatment which approached conventional levels of significance ($F = 2.60$, $p = 0.08$). As in the fourth grade results, all other F ratios failed to

TABLE 30

Summary: Analysis of Variance

Grade 4

Variable		Treatment	Block	Treatment by Block Interaction
Mathematics Computation (CTBS)	F ratio	0.34	24.63	1.36
	F Prob	0.71	0.00	0.23
Mathematics Concepts (ITBS)	F ratio	1.02	48.00	1.13
	F Prob	0.36	0.00	0.35
Attitude Toward Mathematics	F ratio	0.23	34.92	0.84
	F Prob	0.80	0.00	0.54
Academic Self-Concept	F ratio	0.56	22.73	1.88
	F Prob	0.57	0.00	0.09
Mathematics Self-Concept	F ratio	0.72	19.99	0.38
	F Prob	0.49	0.00	0.89
External Locus of Control	F ratio	0.44	17.92	0.60
	F Prob	0.65	0.00	0.73

TABLE 31

Summary: Analyses of Variance

Grade 5

Variable		Treatment	Block	Treatment by Block Interaction
Mathematics Computation (CTBS)	F ratio	1.16	44.39	0.54
	F Prob	0.32	0.00	0.78
Mathematics Concepts (ITBS)	F ratio	1.70	44.12	1.57
	F Prob	0.19	0.00	0.16
Attitude Toward Mathematics	F ratio	0.28	18.12	2.14
	F Prob	0.76	0.00	0.05
Academic Self-Concept	F ratio	0.31	51.10	2.53
	F Prob	0.74	0.00	0.02
Mathematics Self-Concept	F ratio	0.33	30.28	0.50
	F Prob	0.72	0.00	0.81
External Locus of Control	F ratio	2.60	24.25	0.81
	F Prob	0.08	0.00	0.56

approach conventional levels of significance. Again paralleling the fourth grade results, the F ratios for blocks were statistically significant, indicating that the initial ability level of the pupils accounted for the greatest amount of variance in the post scores. Of the six possible treatment by block interactions, two received F ratios which reached conventional levels of significance. The F ratio for the attitude toward mathematics treatment by block interaction was 2.14 with an associated probability of 0.05, and the F ratio for the academic self-concept treatment by block interaction was 2.53 with an associated probability of 0.02. The other four interaction terms failed to approach conventional levels of significance.

The apparent lack of differences between the Minicourse 5 and math-only treatments as illustrated by the above data might have been expected. As was noted in Chapter IV, the tutors in these two treatments showed little, if any, difference in their use of the specified tutoring skills. On the other hand, the few differences among the treatment students and the control students were somewhat unexpected. Further discussion of these findings will be presented in Chapter VII.

CHAPTER VI

RELATIONSHIPS OF TUTORING SKILLS TO PUPIL OUTCOMES*

The analyses described here parallel those conducted for the Mathematics Tutoring Study in which teachers served as tutors (see Williams, et al., 1976). They represent an attempt to identify particular combinations of tutoring skills or interpersonal behaviors which are positively related to specific pupil outcomes. These analyses are exploratory in nature and should be viewed as providing a potential source of hypotheses that might be pursued in experimental studies, particularly since the sample sizes are relatively small compared to the number of variables, and there is undoubtedly considerable capitilization on chance.

The results reported below are based on complete data cases. They are presented in two major sections: (1) the deviation analyses, and (2) the communality analyses.

Deviation Analyses

For the deviation analyses the control group pupils were used to estimate the slope and intercept of each posttest score on the corresponding pretest. These regression coefficients were then applied to the pretest scores of the Minicourse 5 and mathematics only trained tutor groups to obtain "expected" posttest scores. The deviation score for each tutored pupil was then obtained by subtracting the "expected" posttest score from his observed posttest score. Group mean deviation scores

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*The analyses reported in this chapter as well as the chapter narrative were completed by Dr. Robert L. Linn, University of Illinois, Urbana, Illinois.

and correlations of the deviation scores with the tutor observation variable scores were then computed.

While not needed in the deviation analyses, per se, the pretest-posttest correlations for each treatment group at each grade level are reported in Table 32. These correlations provide an indication of the strength of the pretest-posttest relationship within each group. Generally, the correlations are reasonably high. Some fluctuation in the magnitude of corresponding correlations from group to group and from grade to grade may be noted, but given the relatively small sample sizes the correlations generally appear quite consistent.

In Table 33, the control group slopes and intercepts are reported. These are the values that were used to compute "expected scores" for the experimental groups.

The mean deviation scores for the experimental treatment groups are reported in Table 34. In the absence of a treatment effect, these mean deviation scores would be expected to be close to zero. A rough test of the hypothesis that a given deviation score mean was equal to zero was obtained by computing t-ratios for each variable. Only 4 of the 24 deviation means in Table 34 had significant t ratios at the .05 level, and it should be noted that the means on the CTBS, at both grade levels, were included in the four. These tests should be viewed only as rough guides. In any event, they provide only weak evidence for any treatment effects, and the analyses of covariance are better suited to testing for treatment effects.

In order to see if particular tutoring skills or interpersonal behaviors were related to pupil outcomes, the deviation scores in each

TABLE 32

Correlations Between Pre- and Posttest for Complete Data Cases

Variable	Minicourse 5 + Mathematics Trained Tutors (N = 43)	Mathematics Only Trained Tutors (N = 34)	Control Pupils (No Tutors) (N = 71)
Grade 4			
Mathematics Computation (CTBS)	.45	.49	.68
Mathematics Concepts (ITBS)	.86	.59	.72
Attitude Toward Mathematics	.64	.68	.69
Academic Self-Concept	.38	.74	.68
Mathematics Self-Concept	.44	.77	.61
External Locus of Control	.73	.68	.39
Grade 5			
Variable	(N = 43)	(N = 42)	(N = 63)
Mathematics Computation (CTBS)	.65	.73	.74
Mathematics Concepts (ITBS)	.55	.88	.77
Attitude Toward Mathematics	.65	.65	.34
Academic Self-Concept	.85	.62	.67
Mathematics Self-Concept	.72	.71	.56
External Locus of Control	.64	.59	.60

TABLE 33

Control Group Regression Coefficients

Posttest on Pretest

Variable	Grade 4		Grade 5	
	Intercept	Slope	Intercept	Slope
Mathematics Comp't (CTBS)	13.08	.678	8.56	.743
Mathematics Concepts (ITBS)	6.94	.824	6.36	.830
Attitude Toward Mathematics	153.56	.680	324.17	.317
Academic Self-Concept	159.69	.812	299.70	.718
Mathematics Self-Concept	114.18	.613	104.23	.662
External Locus of Control	185.24	.369	138.94	.512

TABLE 34

Means of Experimental Group Deviations From Supplemental Treatment Group Regression Lines

Variable	Grade 4		Grade 5	
	Minicourse 5 + Mathematics Trained Tutors (N = 42)	Mathematics Only Trained Tutors (N = 26)	Minicourse 5 + Mathematics Trained Tutors (N = 39)	Mathematics Only Trained Tutors (N = 36)
Mathematics Comp't (CTBS)	3.00*	.88	4.14*	2.16
Mathematics Concepts (ITBS)	-.67	.38	-.45	.88
Attitude Toward Mathematics	4.32	4.33	-3.21	8.40
Academic Self-Concept	22.26	26.56	-43.71*	-20.11
Mathematics Self-Concept	10.80	12.36	10.24	6.27
External Locus of Control	-8.72	-14.49	9.70	-21.02*

*Significantly different than zero at .05 level.

group were correlated with the 12 tutor variables. Correlations between deviation scores and tutor variables that exceed .30 in absolute value are reported in Table 35. The first column of Table 35 lists the deviation variables that correlate .30 or higher with each tutor variable.

Eighteen correlations are reported in Table 35. These are the largest values observed out of a total of 288 correlation coefficients computed between tutor and deviation variables. None of the correlations exceeds .50. Also, there is no replication of the same pair of variables exceeding .30 within the same group across grade levels. Furthermore, the sample sizes for these correlations are quite small. Thus, there appears to be little evidence that particular tutor skills or interpersonal behaviors influence pupil outcomes, a finding that is consistent with the general lack of difference in performance of pupils across the treatment conditions.

Communality Analyses

Five major clusters of predictor variables were identified for use in the communality analyses. These were: (A) pupil pretest scores, (B) tutoring skills which focus on performance, (C) skillfulness of tutor in demonstration techniques, (D) interpersonal behavior of tutor, and (E) the treatment variable. Clusters B, C, and D were made up of the 12 tutor variables used in the deviation analyses. Cluster A contained all 6 pretests and Cluster E contained 1 dummy variable.

TABLE 35

Observation Variables That Correlate |.30| Or Greater With

Deviation Scores (Value of Correlation in Parenthesis)

Deviation Variable	Grade 4		Grade 5	
	Minicourse 5 Trained Tutors	Mathematics Only Trained Tutors	Minicourse 5 Trained Tutors	Mathematics Only Trained Tutors
Mathematics Computation (CTBS)		Eval. P. (-.34)	Diag.Q. (.34)	Dec. S. (.33)
		Rapport (-.33)	Criticism (.37)	
Mathematics Concepts (ITBS)	Prompting (.31)			
Attitude Toward Mathematics		Mot. S. (.34)		
Academic Self-Concept			Criticism (-.31)	Diag. Q. (-.32)
				Prompting (.33)
				Dec. S. (.44)
Mathematics Self-Concept		Diag. Q. (-.41)		Eval. P. (.36)
External Locus of Control	Eval. P. (.32)		Diag. Q. (-.31)	Mot. S. (.40)
	Mot. S. (.35)		Criticism (-.30)	

The specific variables in each cluster were:

Cluster		Variable
A	1	CTBS
	2	ITBS
	3	Math Attitude
	4	Academic self-concept
	5	Math self-concept
	6	Locus of control
B	1	Diagnostic questioning
	2	Prompting
	3	Evaluation problems
	4	Practice problems
C	1	Demonstration techniques (time)
	2	Demonstration techniques (freq.)
D	1	Praise
	2	Rapport
	3	Motivating statements
	4	Declarative statements
	5	Criticism (constructive)
	6	Recrimination
E	1	Minicourse 5 trained tutor vs. mathematic only trained tutor

These five clusters of variables were entered into multiple regression equations for each of the 6 posttest variables at each grade level. Squared multiple correlations (SMC) were computed for various combinations of predictor clusters. The SMC's were then used to compute estimates of the unique contribution of each cluster of variables. Specifically, if SMC (ABCDE) represents the squared multiple correlations when all predictor variable clusters in the parentheses are used, then the uniqueness for Cluster A, U(A), is:

$$U(A) = SMC(ABCDE) - SMC(BCDE).$$

The primary focus in the communality analyses is on the uniqueness estimates. Of particular interest are any large uniqueness estimates for Clusters B, C, D, or E. These are variables which presumably can be manipulated and, where found to have large uniqueness estimates, would be expected to influence pupil performance.

Of secondary interest is the joint contribution of combinations of clusters or the unique contributions of individual variables within a cluster. Joint contributions could be estimated for all possible combinations of clusters but probably would not be worthwhile. Considerably more calculation would be required for this and it is doubtful that the results would be interpretable. Indeed, some of the estimated joint contributions would undoubtedly be negative which makes no substantive sense. What can be obtained with little effort from the results presented below is an estimate of the sum of all the joint terms involving a particular cluster of variables. For example, the joint contribution of Cluster A with all combinations of the other variables, J (A - Total), is

$$J(A - Total) = SMC (A) - U (A).$$

It was originally suggested in the research proposal that unique estimates of individual variables within a cluster would be obtained only if a cluster had a unique component that was judged to be large. As will be seen below, there are relatively few, if any, clusters that would seem to justify this secondary analysis. In any event, such analyses have not been attempted.

The results of the communality analyses are presented in Tables 36 through 41. Each of these tables presents the fourth and fifth grade results for one of the six posttest variables. Listed are the squared multiple correlations of each cluster individually for the five possible combinations of four clusters at a time and for all five clusters combined. These are the only SMC's that are required to obtain the uniqueness estimates and total joint estimates discussed above. Also listed in the tables are the uniqueness estimates for each cluster.

Total joint estimates are not listed but are readily obtainable by subtracting the uniqueness estimate for a given cluster from the SMC for that cluster alone. If this is done, some of the joint term estimates will be found to be negative.

A comparison of the relative size of the uniqueness estimates in the six tables shows that Cluster A has the largest uniqueness estimate in all twelve sets of estimates. This is hardly surprising in view of the substantial body of evidence that previous student characteristics account for much more variability in later pupil performance than any other variables. It also is consistent with the results from the study of Teachers as Tutors in which Cluster A was found to have the largest uniqueness estimate in 11 of 12 cases.

Among Clusters, B, C, D, and E--i.e., those involving variables other than pupil pretest scores--Cluster D has the largest uniqueness estimate in 9 of the 12 sets; Cluster B is largest in 2 of the 12; and Clusters B and D are tied for high in the remaining set of results. This may be partially an artifact since among Clusters B, C, D, and E, Cluster D had the most variables (6) and Cluster B had the second greatest number (4). Clusters C and E had only 2 and 1 variables respectively.

With the small sample sizes available for the regression analyses and the large number of variables, what indications there are that variables in Cluster D or Cluster B may be important must be considered weak at best.

TABLE 36

Squared Multiple Correlations and Uniqueness Estimates

(Dependent Variable - CTBS)

	Grade 4 (N=68)		Grade 5 (N=75)	
Predictor Cluster	Squared Multiple	Uniqueness	Squared Multiple	Uniqueness
A	.380	.305	.582	.526
B	.010	.026	.031	.011
C	.025	.004	.006	.008
D	.065	.043	.061	.073
E	.002	.014	.013	.014
ABCD	.433		.667	
ABCE	.404		.608	
ABDE	.443		.673	
ACDE	.421		.670	
BCDE	.142		.155	
ABCDE	.447		.681	

TABLE 37

Squared Multiple Correlations and Uniqueness Estimates

(Dependent Variable - ITBS)

	Grade 4 (N=68)		Grade 5 (N=75)	
Predictor Cluster	Squared Multiple	Uniqueness	Squared Multiple	Uniqueness
A	.679	.551	.691	.594
B	.015	.027	.041	.018
C	.042	.006	.019	.002
D	.057	.052	.079	.024
E	.022	.000	.015	.006
ABCD	.751		.739	
ABCE	.699		.721	
ABDE	.745		.743	
ACDE	.727		.727	
BCDE	.200		.151	
ABCDE	.751		.745	

TABLE 38

Squared Multiple Correlations and Uniqueness Estimates

(Dependent Variable - Attitude Toward Mathematics)

	Grade 4 (N=68)		Grade 5 (N=75)	
Predictor Cluster	Squared Multiple	Uniqueness	Squared Multiple	Uniqueness
A	.534	.269	.579	.526
B	.088	.034	.052	.025
C	.027	.003	.004	.034
D	.151	.034	.053	.035
E	.001	.006	.021	.013
ABCD	.598		.623	
ABCE	.570		.601	
ABDE	.601		.632	
ACDE	.570		.611	
BCDE	.335		.110	
ABCDE	.604		.636	

TABLE 39

Squared Multiple Correlations and Uniqueness Estimates

(Dependent Variable - Academic Self-Concept)

	Grade 4 (N=68)		Grade 5 (N=75)	
Predictor Cluster	Squared Multiple	Uniqueness	Squared Multiple	Uniqueness
A	.474	.329	.607	.598
B	.081	.020	.021	.026
C	.021	.005	.010	.016
D	.165	.063	.054	.035
E	.000	.000	.000	.000
ABCD	.603		.688	
ABCE	.540		.653	
ABDE	.598		.672	
ACDE	.583		.662	
BCDE	.274		.090	
ABCDE	.603		.688	

TABLE 40

Squared Multiple Correlations and Uniqueness Estimates

(Dependent Variable - Math Self-Concept)

	Grade 4 (N=68)		Grade 5 (N=75)	
Predictor Cluster	Squared Multiple	Uniqueness	Squared Multiple	Uniqueness
A	.499	.416	.621	.604
B	.051	.034	.025	.043
C	.023	.009	.012	.009
D	.092	.057	.013	.020
E	.000	.010	.001	.004
ABCD	.584		.676	
ABCE	.537		.660	
ABDE	.585		.671	
ACDE	.560		.637	
BCDE	.178		.076	
ABCDE	.594		.680	

TABLE 41

Squared Multiple Correlations and Uniqueness Estimates

(Dependent Variable - Locus of Control)

	Grade 4 (N=68)		Grade 5 (N=75)	
Predictor Cluster	Squared Multiple	Uniqueness	Squared Multiple	Uniqueness
A	.588	.418	.443	.459
B	.096	.020	.077	.056
C	.004	.004	.008	.000
D	.148	.019	.095	.128
E	.000	.000	.000	.025
ABCD	.649		.583	
ABCE	.630		.480	
ABDE	.645		.608	
ACDE	.629		.552	
BCDE	.231		.149	
ABCDE	.649		.608	

Analysis of Tutoring Time

An analysis of variance of tutoring time was performed for the two groups of tutors to determine whether tnere were significant variations in the amount of tutoring conducted that could be related to pupil outcomes. The results are presented in Table 42.

TABLE 42

Tutoring Time

Minicourse 5 and Mathematics Trained Tutors
and
Mathematics Only Trained Tutors

Analysis of Variance

Source	DF	SS	MS	F Ratio	F Prob
Between Groups	1	32.00	32.00	0.003	0.48
Within Groups	172	2110448.00	12270.04		
Total	173	2110480.00			

Group	N	Mean	SD	SE	95% Confidence Interval
Minicourse 5	94	428.77	105.25	10.86	407.21 to 450.32
Mathematics Only	80	429.61	116.94	13.07	403.59 to 455.64
Total	174	429.16	110.45	8.37	412.63 to 445.68

Cochran's C = 0.55, p = 0.17 (approx.)

An examination of Table 42 shows an F ratio of 0.003 which indicates that there were essentially no differences between the Minicourse 5 tutors and the mathematics trained only tutors in the amount of time spent in tutoring. This analysis, then, effectively negates the competing

hypothesis that any differences in outcomes for the pupils in this study could be related to the differential amount of time spent in tutoring between the two tutoring treatments.

CHAPTER VII

DISCUSSION OF RESULTS

The discussion of the results of this study is organized according to the research questions asked on page 63. Each question is restated, and the analyses which answer the question are summarized and discussed separately by grade level. After all questions have been individually discussed, a summary section synthesizes the results.

Question 1: Are there differential results from systematic mathematics tutoring associated with the initial ability level of tutored pupils on a set of dependent variables?

The comparisons which are being made in the above question are among the pupils of Minicourse 5 trained tutors, mathematics only trained tutors, and the control group within each of the four blocks representing different ability levels.

For fourth grade pupils, this question was answered through the use of a set of block by treatment analyses of variance and the Studentized Newman-Keuls comparisons of means within each block. An affirmative answer to the question was provided only for the academic self-concept measure. In blocks 1 and 2 (the blocks which contained pupils with lower prescores on a given dependent measure), fourth grade pupils in the Minicourse 5 treatment received higher mean scores on the academic self-concept measure than did the pupils in the mathematics only and control treatments; in blocks 3 and 4, however, the mean scores of the Minicourse 5 pupils were lowest. The resulting interaction approached conventional levels of significance with a probability of occurrence of 0.09. (See Table 24 and Figure 4, pages 78 and 80.) Close examination of Figure 4 shows

that pupils in the Minicourse 5 treatment with initially low academic self-concept (blocks 1 and 2), made greater improvement in their post treatment self-concept scores than pupils with initially higher academic self-concept (blocks 3 and 4). This phenomenon did not occur in either of the other treatments--that is, the ordering of the post mean scores for the mathematics only and control pupils reflected the ordering in the original blocks. The results seem to indicate that there was a differential effect on academic self-concept for fourth grade pupils in the Minicourse 5 treatment dependent upon the initial level of academic self-concept of the pupils.

The Studentized Newman-Keuls test for academic self-concept detected differences among the three treatments which were significant at the 0.05 level of probability only in block 3. In contrast with the blocks 1 and 2 findings, the mean scores of the mathematics only pupils were significantly higher than those of the Minicourse 5 pupils. Neither the Minicourse 5 nor mathematics only mean scores were significantly different from those of the control pupils. It therefore appears that tutoring of the type presented in Minicourse 5 helps build self-concept of fourth grade pupils who have a low self-concept more so than those who have a high self-concept prior to the initiation of tutoring. What is not known is whether this is because the low pupils have room to grow while the high pupils do not or whether the treatment has differential effects.

For fifth grade pupils, an affirmative answer to Question 1 was provided for the attitude toward mathematics measure. The treatment by block interaction was significant at the 0.05 level of probability. This result can be accounted for by the fact that the mathematics only

pupils in block 1--the pupils with very low pre-attitude scores--had post mean scores which were considerably lower than those of the Minicourse 5 and control group pupils who initially also had low scores (See Table 23, page 75. In the other three blocks, the mean scores of the three treatment groups were very similar.

On the academic self-concept measure, the mathematics only fifth grade pupils in blocks 1 and 3 received lower mean scores than the Minicourse 5 and control group pupils in those blocks. In blocks 2 and 4, by contrast, the means of the mathematics only group were higher than those of the pupils in the other two treatments (See Table 25 , page 79). The resulting treatment by block interaction was significant at the 0.02 probability level. The studentized Newman-Keuls test was applied to the means in each block for this variable. In block 2, the mean score of the Minicourse 5 pupils was significantly lower ($p = 0.05$) than those of the mathematics only and control pupils. No other differences approaching conventional levels of significance were detected in any block. The effect of the Minicourse 5 treatment on academic self-concept for pupils who initially had very low concepts seems to have occurred in fifth as well as fourth grade.

For all other dependent variables, the nonsignificant F ratios for the treatment by block interaction indicated that differential results did not occur based on the entry level of the pupils. The results for both the fourth and fifth grade pupils were sufficiently erratic to appear to represent chance occurrences.

No a priori predictions were made concerning the specific answers expected to Question 1. However, it was expected that significant treatment by block interactions would occur, indicating that pupil outcomes

were different depending on the pupil's initial level of ability and the treatment to which (s)he was assigned. This obviously did not occur.

In exploring possible reasons for the lack of treatment by block interaction, the range of grade equivalent scores for each block on each of the mathematics achievement premeasures was examined. These scores are presented in Table 43.

It is entirely possible that the range of scores for each block at the different grade levels, as presented in Table 43, was not great enough to reflect highly diverse ability groupings. It also is possible that the range of scores within a block represented diverse abilities, thus creating a situation in which differential effects occurred within one or more of the blocks, thereby masking the overall treatment by block interaction. A more plausible explanation is that the treatment was too weak to have the expected effect on any of the pupils, regardless of ability level.

Among the affective measures, only academic self-concept yielded positive results for both fourth and fifth grade pupils. Although the data do indicate that post scores on the academic self-concept measure were related to treatment and block, the configuration of the interaction was not the same at both grade levels (See Figures 3 and 4, pages 76 and 80), thus leading one to suspect that the results either were a function of grade level in addition to treatment and block or were random occurrences. This is an hypothesis which could be tested in future mathematics tutoring studies.

The only other measure which yielded a treatment by block interaction that reached conventional levels of significance was the fifth grade attitude toward mathematics measure. Interpretation of this result is

TABLE 43

Range of Grade Equivalent Scores by Block

on the Mathematics Achievement Pre Measures

Measure	Block	Grade 4		Grade 5	
		Grade Equivalent	# of Items	Grade Equivalent	# of Items
CTBS	1	1.3 -- 2.5	1 - 8	1.3 -- 3.2	1 - 14
	2	2.6 -- 3.6	9 - 18	3.3 -- 4.3	15 - 25
	3	3.7 -- 4.5	19 - 27	4.4 -- 5.4	26 - 36
	4	4.6 --	28 -	5.5 --	37 -
ITBS	1	1.4 -- 2.5	0 - 5	1.8 -- 3.0	0 - 6
	2	2.6 -- 3.5	6 - 12	3.1 -- 4.4	7 - 13
	3	3.6 -- 4.7	13 - 19	4.5 -- 5.6	14 - 20
	4	4.8 --	20 -	5.7 --	21 -

difficult because while the pupils in the upper three blocks remained fairly stable as related to their prescores, the block 1 Minicourse 5 and control pupils had much more positive posttest attitudes toward mathematics than did the block 1 pupils in the mathematics only treatment. The reader is reminded that the pupils in block 1 were those who had the lowest initial attitude toward mathematics. Although not testable with the present data, it is possible that the Minicourse 5 training received by the tutors made them more nearly like classroom teachers in their treatment of pupils with initially low mathematics attitudes, thus creating a situation in which these pupils' attitudes towards mathematics would become more positive than that of the pupils tutored by paraprofessionals trained only in mathematics.

Question 2: Do pupils who receive systematic mathematics tutoring from tutors trained in tutorial skills perform better on a set of dependent variables than pupils of comparable ability who receive systematic mathematics tutoring from tutors who have not had mathematics tutoring training?

The comparison being made in Question 2 is between the pupils of Minicourse 5 and mathematics only trained tutors. The Studentized Newman-Keuls test was applied to the marginal treatment means in an attempt to answer this question.

For fourth grade pupils, the Studentized Newman-Keuls test detected no significant differences between the Minicourse 5 and mathematics only pupils on any of the dependent measures. Although statistically nonsignificant, mathematics only pupils had higher mean scores than the Minicourse 5 pupils on both the achievement measures and the external locus of control measure. The reverse occurred on the remaining three affective

measures (attitude toward mathematics, academic self-concept, and mathematics self-concept). The means of the two groups of tutored pupils were so close, however, that the results would appear to be chance occurrences.

On the fifth grade ITBS, the Studentized Newman-Keuls detected a significant difference between the Minicourse 5 and mathematics only treatment pupils in favor of the latter group ($p<0.05$). No other significant differences were detected on the fifth grade dependent variables. Among the five remaining variables, an affirmative but statistically nonsignificant answer was provided for the CTBS and the external locus of control measure. That is, for both these variables, the mean of the Minicourse 5 pupils was higher than that of the mathematics only pupils. For the remaining affective measures--attitude toward mathematics, academic self-concept, and mathematics self-concept--the means of the mathematics only pupils were highest.

These data lead to the conclusion that, in general, training in tutorial skills through Minicourse 5 made no difference in either the mathematics or affective outcomes of the fourth and fifth grade pupils in this study. These results are supportive of those which were obtained in the Teacher Mathematics Tutoring Study (Williams, et al, 1976). In that study, teacher tutors in the two tutoring treatments (Minicourse 5 trained tutors and regular tutors who received no Minicourse 5 tutor training) used the tutoring strategy similarly, and the pupils in the two tutoring treatments had similar mathematics and affective outcomes.

In the present study, the paraprofessional tutors in both treatments exhibited similar use of the skills taught in the Minicourse (see Table 14, page 61). The two groups of tutors were alike in their use of all tutoring skills, with the largest differences being present for use of praise

(in favor of the mathematics only tutors). Of particular importance is the low usage by both groups of tutors of demonstration techniques and the failure to assign practice problems. This could be explained by an essentially weak training program, although skill usage in other areas was not particularly low. Or it could be explained as another effect of the strike which interrupted the study. With almost half of the original tutors leaving the study during the strike for other employment, it is possible that those who were left to continue were the less capable tutors. The present data do not allow this question to be answered.

The data do indicate that adults placed in a tutoring situation will employ a number of logically sound strategies whether or not they are given special training in tutorial skills. The absence of differences between the pupils in the two treatments, therefore, could be expected inasmuch as the treatments themselves differed very little.

Question 3: Do pupils who receive systematic mathematics tutoring perform better on a set of dependent variables than pupils of comparable ability who receive no systematic mathematics tutoring?

Answering this question requires a comparison between the pupils who were tutored, by either Minicourse 5 or mathematics only tutors, and the control treatment pupils who were not tutored. The Studentized Newman-Keuls test of means was used to examine the means of the two groups of pupils.

For fourth grade pupils, no differences approaching conventional levels of significance were detected by the Studentized Newman-Keuls test on any of the dependent variables. An affirmative, but statistically nonsignificant, answer to Question 3 was obtained for only two of the six variables--mathematics computation (CTBS) and attitude toward

mathematics. On these variables, the mean scores of the pupils in both tutoring treatments were higher than those of the control pupils. On two of the remaining four variables, the academic and mathematic self-concept scales, the mean scores of the Minicourse 5 treatment pupils, but not of the mathematics only pupils, were higher than those of the control pupils. The mean scores of the control pupils were highest on the ITBS and external locus of control measure, thus giving a negative answer to Question 3 for those two variables.

For the fifth grade, none of the Studentized Newman-Keuls comparisons approached conventional levels of significance. However, affirmative answers to Question 3 were provided for mathematics computation (CTBS), mathematics self-concept, and external locus of control. For each of these variables, the mean scores of the pupils in the two tutoring treatments were higher than those of the control pupils. For the ITBS and the Attitude Toward Mathematics measure, the mathematics only treatment pupils, but not the Minicourse 5 treatment pupils, had higher mean scores than the control pupils, thus giving a partial affirmative answer to the question. The results for the Academic Self-Concept measure provided a negative answer to Question 3; the control group pupils, who were not tutored, had higher mean scores than the pupils in the tutoring treatments.

These results indicate that the tutoring by the paraprofessional tutors had no significant effect on the mathematics achievement or affective outcomes of the pupils whom they tutored, as contrasted to the control pupils who were not tutored. However, trends were demonstrated at both grade levels in favor of tutoring. On the CTBS, tutored pupils in fourth and fifth grades received higher mean scores than their respective control pupils. At the fifth grade level, this result was repeated for attitude

toward mathematics, mathematics self-concept, and external locus of control. For three other dependent measures--fourth grade academic self-concept, fourth grade mathematics self-concept and fifth grade ITBS--the mean of one tutoring treatment exceeded the mean of the control group. The results, then, although statistically nonsignificant, indicate the tutoring may have affected the mathematics and affective outcomes of pupils.

In exploring possible reasons for the lack of significant differences between tutored pupils and control pupils, it is necessary to look closely at the conditions created because of the city employees' strike (see page 18). First, 17 tutors were unable to continue in the study, resulting in approximately 100 pupils in the tutoring treatments being dropped from the study when it was resumed. Although those pupils were nearly equally divided between the two treatments, no similar reduction in the control group occurred. The available data do not help to determine what effect this may have had on the final results.

Second, although tutoring did occur as scheduled throughout the nine weeks of the study (see Fidelity of Treatment, page 18), it is difficult to determine whether the tutoring treatment should be considered a six week treatment (the time remaining after the strike was settled) or a nine week treatment (the total number of weeks that tutoring occurred, excluding the three week period of inactivity). Further, it is not known whether even an interrupted nine week period of tutoring would allow time for improvement in the mathematics skills or in the affective outcomes of the pupils, particularly since the atmosphere in the regular classroom may have produced important intervening variables during this time period because of tension created by the strike.

Question 4: Are there particular combinations of tutoring skills or interpersonal behaviors which are positively related to specific pupil outcomes?

The design of the Math Tutoring Study allowed for the collection of information concerning paraprofessional use of selected tutoring skills and other specified interpersonal behaviors in the tutorial setting. These observational data make it possible to provide answers to Question 5 without regard to the particular treatment condition of the tutor.

Chapter VI reports the results of the analyses related to this question. In summary, the deviation analysis provided no information which would provide further knowledge about the effects of tutoring in general or about selected skills and strategies in particular on specific pupil outcomes. The communality regression analysis provided slightly more information. As would be expected, the pupil pretest scores accounted for the greatest amount of variance in post test scores for each variable.

After accounting for the unique variance of pupils' initial status, two of the remaining four clusters of variables provided small but unique contributions to variance. These were (1) Cluster D, which included praise, rapport, motivating statements, declarative statements, criticism, and recrimination, and (2) Cluster B, comprised of diagnostic questions, prompting questions, evaluation problems, and practice problems. These results parallel those which were obtained in the study of teachers as tutors.

Inasmuch as the results from the paraprofessional and teacher tutoring studies are similar, there appears to be some support for considering the variables in Clusters B and D of importance in relationship to pupil outcomes which result from tutoring. A salient issue is whether the amount of variance attributable to these skills and behaviors is large

enough to establish them as important elements in the tutoring act. In the paraprofessional study reported herein, less than one percent of the variance in pupil posttest scores on each of the dependent measures, with the exception of the fifth grade external locus of control measure, could be attributed to Cluster D, after adjustment on the pre scores. For the external locus of control measure, 1.6 percent of the variance in pupil adjusted posttest scores could be accounted for by Cluster D. Given these percentages, questions must be raised regarding not only the training that was conducted to develop tutorial skills but also the tutoring process itself. Clusters B and D, combined, represent the positive components of most tutorial situations. Given the limited size of these clusters' contribution to learning, questions must be asked concerning the time and monetary expenditures necessary to initiate and conduct tutoring programs.

Summary

Before summarizing the results of the Math Tutoring Study, several unique aspects of the study should be pointed out. Of prime importance was the fact that fourth and fifth grade pupils in all participating schools were randomly selected from the available population of pupils in those schools to participate in the study. Selected pupils were stratified according to mathematics computation ability, sex, and grade, and then randomly assigned to tutors who in turn were randomly assigned to treatment conditions. All treatments were present in each of the nine participating schools. Tutorial training procedures were faithfully followed, and the training materials which were used had previously been subjected to a rigorous research and development cycle.

The pupil outcome variables were chosen from those most recommended in the literature, and the mathematics measures were chosen to be reactive to the curriculum in the participating schools and to the tutoring treatment. The tutoring treatment was identified and documented through the use of tutor logs and a trained observer who collected data on the use of skills and on specified affective behaviors during the actual tutoring sessions.

In addition, the present study represented a partial replication of the Teachers as Tutors Study in that the same tutor skills were examined, the dependent variables were identical, and the population of tutored pupils were, again, fourth and fifth grade pupils. Through the use of similar research designs, the possibility of more generalizability of positive results was created.

The foregoing features of the study are illustrative of the care and control that were exercised in designing a study that would overcome many of the methodological weaknesses evident in prior studies of tutoring. It was felt that these experimental controls reduced the number of available competing hypotheses that could also account for the results of the study. Despite these experimental controls, the situation created by the strike may have served to nullify many of the experimental conditions which were designed. There is no way to assess the effects of the strike on the results of the study, but it certainly is necessary to raise questions concerning those effects.

Overall, then, the results of the Math Tutoring Study: Paraprofessionals as Tutors may be summarized as follows:

1. Pupil outcomes in mathematics achievement and in affective areas based upon participation or non-participation in systematic mathematics tutoring were generally not related to pupils' initial status on the dependent variables.

2. Training in tutorial skills was found to have no significant effect upon pupil outcomes in mathematics achievement or upon attitudes when pupils tutored by trained and untrained tutors were compared.

3. Differences in mathematics achievement and in the affective areas were found to be nonsignificant when tutored pupils were compared with a control group of pupils who did not receive tutoring from paraprofessional tutors, although trends in favor of tutored pupils were evident.

4. The communality regression analyses demonstrated that the cluster of variables which contained the pupil pretest scores accounted for the greatest amount of variance in pupils' adjusted post scores. However, the cluster which contained the interpersonal behaviors of tutors provided a small but unique contribution for nine of the twelve dependent variables, and the cluster which contained the skills emphasized in Minicourse 5: Individualizing Instruction in Mathematics provided a small but unique contribution to variance in two of the twelve dependent variables. Overall, a relationship between tutoring skills and interpersonal behaviors of tutors to pupil outcomes was not strongly demonstrated.

Given the results of this study, questions must certainly be raised concerning the quantity and quality of the treatment that was present. Over the nine week duration of the study, pupils were tutored for an average of 50 minutes per week. In the majority of the studies reported in the literature which show positive growth in mathematics achievement and/or attitudes towards mathematics as a result of tutoring, tutoring was scheduled for a minimum of 60 minutes per week (see Van Mondfrans, 1968; Rogers, 1969; Schoeller and Pearson, 1970; Bausell, Moody, and Walzl, 1972; and Salomon and Achenback, 1974). It is entirely possible that the treatment in this study was not strong enough to positively influence mathematics achievement and attitudes.

A more difficult question to address is concerned with the quality of the treatment. The tutoring skills upon which the Minicourse is based are those skills emphasized in the mathematics remediation literature. The results from this study document the fact that these skills are used by adults in the tutorial setting, whether or not they receive tutorial training (see Table 14 page 61). The study further indicates that there is little relationship between usage of the tutorial skills emphasized in Minicourse 5 and positive pupil outcomes in mathematics achievement and attitudes. The methodology employed in the present study does not allow exploration of the quality of treatment, although this is an area which should be studied in research on teaching. It is possible that skills should be studied in combination, rather than singly, and that attention should be given to appropriateness of skill usage.

In conclusion, whether because of an insufficient treatment in terms of time spent in tutoring, because of the specific skills and affective

behaviors which were chosen for study, because of the more stringent experimental controls in this study, or because of the intervention of the strike, this study failed to demonstrate that mathematics achievement and attitudes could be increased as a result of tutoring or training in tutorial skills. As these results conflict with those found in most mathematics literature, replication of this study is recommended.

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APPENDICES

APPENDIX A

Description of Minicourse 5:

Individualizing Instruction in Mathematics

Minicourse 5: Individualizing Instruction in Mathematics

The training of teachers assigned to the Minicourse 5 trained tutor treatment was accomplished through the use of Minicourse 5: Individualizing Instruction in Mathematics. The training schedule is described on pages 38-59; in this appendix, the teaching skills and Minicourse instructional procedures are described.

Minicourse 5 is one of a series of teacher training programs developed and tested by the Far West Laboratory for Educational Research and Development. Published in 1971, it employs an instructional strategy in which teachers study the skills to be acquired, practice them with their own students, and evaluate their own progress in skill acquisition.

The skill practice component of the training cycle utilizes microteaching so called because the teacher applies the skills he is acquiring in a simpler setting than that of the customary classroom environment. In Minicourse 5, microteaching is conducted in a quiet room outside of the classroom where the teacher may devote his attention to the tutoring skills he is practicing. Microteach lessons are videotaped so that the teacher may subsequently play the tape and evaluate his use of the teaching skills with the assistance of self-evaluation forms contained in the course materials.

In a typical Minicourse lesson, the teacher:

1. Reads a chapter of the Teacher Handbook for the course to learn about the teaching skills emphasized in a given lesson.

2. Views an instructional film in which the teaching skills for the lesson are demonstrated in actual lessons.

3. Plans and conducts a microteach lesson in which he seeks to apply the teaching skills he has studied and seen demonstrated.

4. Evaluates his own performance while replaying a videotape of the microteach lesson he has conducted.

5. Reteaches and reevaluates the lesson (with another or the same pupil) to refine his use of the teaching skills.

While these steps may be modified somewhat for specific Minicourse lessons, they reflect the fundamental instructional strategy utilized in Minicourse 5.

The lesson objectives and teaching skills for Minicourse 5 are reproduced below as they appear in the Teacher Handbook used in training teachers for this study.

LESSON 1

Objective: To improve teacher skill in rewarding pupils' correct responses and encouraging their active participation in the tutoring process.

Skills: Using verbal praise to reward correct responses.

Asking prompting questions to increase pupils' active involvement in the tutoring process.

LESSON 2

Objective: To increase teacher skill in diagnosing pupils' deficiencies in understanding mathematical concepts and computational procedures.

Skills: Asking general diagnostic questions (e.g., "How did you get your answer?").

Number operations: asking questions to test pupils' understanding of place value, regrouping, and other number concepts.

Verbal problems: asking questions to test pupils' ability to read the problem and to decide on an appropriate number operation.

LESSON 3

Objective: To increase teacher use of techniques that help to develop pupils' understanding of mathematical concepts and computational procedures.

Skills: Estimating an answer before using a computational algorithm.

Number operations: depending on the situation, using expanded notation, the number line, or manipulative materials.

Verbal problems: having the pupil draw a picture of the problem and write a number sentence to express the problems requirements.

LESSON 4

Objective: To increase teacher skill in evaluating pupil progress and assigning practice examples.

Skills: Assigning an evaluation example.

Assigning practice examples.

LESSON 5

Objective: To improve teacher skill in organizing the mathematics class period for individual tutoring.

Skills: Having pupils correct their own work.

Having pupils tutor each other (peer tutoring).

APPENDIX B

Daily Log

Tutor _____ School _____

Week of _____

Math area for class for week: _____

	SESSION 1/Date:	SESSION 2/Date:
Student: _____	Class Activity: _____ _____ Problem: _____ _____ Comments: _____ _____ _____ _____ Progress? _____ _____ Time Spent: _____	Class Activity: _____ _____ Problem: _____ _____ Comments: _____ _____ _____ _____ Progress? _____ _____ Time Spent: _____
Student: _____	Class Activity: _____ _____ Problem: _____ _____ Comments: _____ _____ _____ _____ Progress? _____ _____ Time Spent: _____	Class Activity: _____ _____ Problem: _____ _____ Comments: _____ _____ _____ _____ Progress? _____ _____ Time Spent: _____

TEACHER LOG -- Control Teachers

Teacher _____

School _____ Grade _____

Week of _____

Indicate those pupils who receive <u>five minutes</u> or more of individual help from you.

Date	Name	Nature of Problem	Time Spent

Indicate the topic that was covered in the 30 minutes of additional mathematics instruction:

_____

APPENDIX C

Paraprofessional Evaluation Form

MATH TRAINING FOR PARAPROFESSIONAL TUTORS

Math training for the paraprofessional tutors was conducted by a Math Resource Teacher from the San Francisco Unified School District along with a member of the Math Tutoring Research Team. The training was designed to insure that all tutors had knowledge of the concepts and skills that were being taught in the 4th and 5th grade classrooms. The topics which were covered are listed below:

1.	Sets, Numbers and Numerations	(2 sessions)
2.	Sentences and Problem Solving	(1 session)
3.	Measurements	(1 session)
4.	Operations and Properties	(1 session)
5.	Geometry	(1 session)
6.	Relations and Functions	(1 session)
7.	Probability, Statistics & Graphing	(1 session)

MATHEMATICS INVENTORY

Name _____

Date _____

INSTRUCTIONS:

This inventory consists of 38 problems pertaining to the math concepts and skills that are taught to 4th and 5th grade students. Each problem is followed by a blank space for recording your answer. The purpose of the inventory is to test your knowledge of these math skills and concepts. This information will be used to identify the areas in mathematics which are to be covered in the training session.

Please work all problems.

Thank you

1

12	42	37
+ 25	+ 36	+ 51

2

35	68	93
- 13	- 46	- 81

3

WRITE THIS AS A COMPACT NUMERAL:

2,000,000 + 700,000 + 5,000 + 8 = _____

4

WRITE THIS IN EXPANDED FORM:

7,105,620 = _____

5

COMPLETE: (42 + 8) + 35 = 42 + (_____ + 35)

THIS IS CALLED ----------PROPERTY.

6

RING THE NUMERAL WITH 5 IN THE HUNDREDS PLACE:

105 562 256

7

USE < > OR = IN THE CORRECT ◯ :

2 ◯ 3 | 7 ◯ 7 | 16 ◯ 9

6 ◯ 5 | 12 ◯ 15 | 8 ◯ 7

8

ROUND OFF TO THE NEAREST HUNDRED.

769 _____

432 _____

9

PUT A LINE UNDER THE AMOUNT THAT IS MORE.

7 Million

3 Billion

10 ROUND OFF TO THE NEAREST THOUSAND.

19,912 _____

5,806 _____

12,076 _____

11 USE EXPONENTS

6^{2}

3^{3}

_____

_____

12 FACTORS

_____

_____

6 X 6 X 6

2 X 2 X 2 X 2

13 COMPLETE THE COUNTING IN BASE FIVE:

0 1 2 3 4 10 11 ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

14 ADD IN BASE FIVE:

42	23	143
+ 31	+ 24	+ 121

15 SUBTRACT IN BASE FIVE:

43	104	132
- 23	- 32	- 43

16

ROMAN NUMERAL	OUR NUMERAL	OUR NUMERAL	ROMAN NUMERAL
XXIII	_____	52	_____
XIX	_____	____	CCVII
XXVII	_____	509	_____

17 WRITE = OR ≠ IN THE BOXES:

6 ☐ 4 + 1

3 + 2 ☐ 6 + 2

4 + 4 ☐ 2 + 6

5 + 7 ☐ 6 + 6

5 + 8 ☐ 4 + 10

18 FIND THE SUMS:

$\frac{2}{4} + \frac{1}{4} =$

$\frac{4}{3} + \frac{1}{3} =$

19

$6 \overline{)59}$

20

$9 \overline{)873}$

21

$4 \overline{)1474}$

22

$$\begin{array}{r} 67 \\ \times\ 50 \\ \hline \end{array}$$

23

$40 \overline{)1076}$

24 Check using multiplication ←

25

$$\begin{array}{r} 7 \\ \times\ 6 \\ \hline \end{array} \qquad \begin{array}{r} 9 \\ \times\ 9 \\ \hline \end{array}$$

26

$$\begin{array}{r} 8 \\ \times\ 6 \\ \hline \end{array} \qquad \begin{array}{r} 9 \\ \times\ 8 \\ \hline \end{array}$$

27

$$\begin{array}{r} 7{,}509 \\ \times\ 8 \\ \hline \end{array}$$

28

$$\begin{array}{r} 870{,}293 \\ -\ 146{,}892 \\ \hline \end{array}$$

29 Round off to nearest 10

27 _____

82 _____

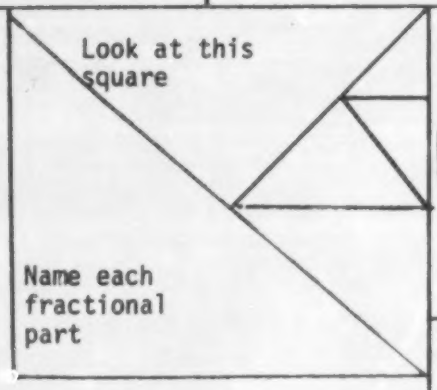
798 _____

30 Find the Product:

(7 X 8) X 3 = ____

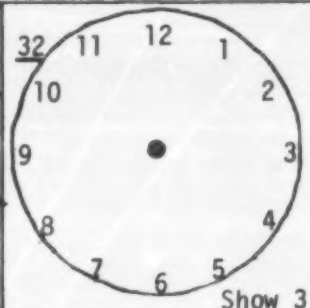
6 X (4 X 5) = ____

31 Look at this square



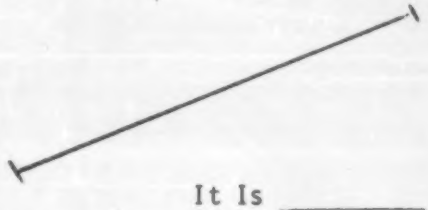
Name each fractional part

32



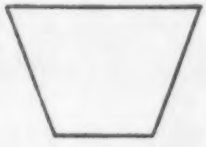
Show 3:52

33 Measure this line segment

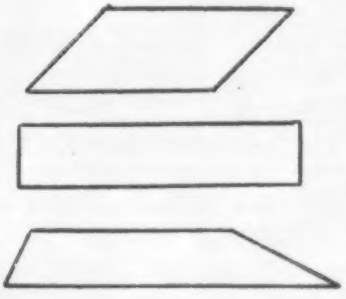


It Is _____

34 Draw 2 Diagonals



35 Match the name to one figure:



rectangle

parallelogram

quadrilateral

36

SET A = (2, 4, 6, 8)

SET B = (5, 7, 9,)

SET C = (2, 3, 4, 5, 6)

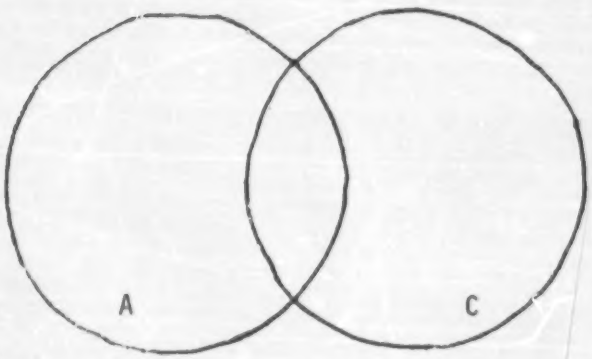
A $\cup$ C = _____ A $\cup$ B = _____

A $\cap$ C = _____ A $\cap$ B = _____

n(A) = _____ n(B) = _____ n(C)= _____

NAME A UNIVERSAL SET FOR SETS A, B, AND C. _____

COMPLETE THIS VENN DIAGRAM FOR SETS A AND C.



37

MEASUREMENT: WRITE THE EQUIVALENTS FOR

1. 2 feet = _____ inches
2. 1 meter = _____ centimeters
3. 1 yard = _____ feet or _____ inches
4. 1000 meters = 1 K_____
5. 7 feet = _____ yards and _____ feet
6. 40 inches = _____feet and _____ inches
7. 127 Cm = _____ m and 27 Cm

38

LIQUID MEASUREMENT:

8. 1 gallon = _____ quarts or _____ pints
9. 4 Cups = _____ pints
10. 20 ounces = _____ cups and _____ ounces
11. $\frac{1}{2}$ Cup = _____ ounces

APPENDIX D

Pretest ANOVAS

California Tests of Basic Skills PRE

Grade 4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	256.4	128.2	1.40	0.25
Within Groups	157	14356.6	91.4		
Total	159	14613.0			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	47	17.2	8.0	1.2	14.9 to 19.5
Math Only	37	19.5	10.1	1.7	16.2 to 22.9
Control	76	20.1	10.2	1.2	17.8 to 22.5
Total	160	19.1	9.6	0.8	17.6 to 20.6

Tests for Homogeneity of Variances

Cochrans C = 0.3871, P = 0.314 (Approx.)

California Tests of Basic Skills PRE

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	170.3	85.1	0.74	0.48
Within Groups	155	17809.1	114.9		
Total	157	17979.4			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	46	24.8	10.2	1.5	21.8 to 27.8
Math Only	44	26.2	11.9	1.8	22.6 to 29.9
Control	68	27.3	10.2	1.2	24.8 to 29.8
Total	158	26.3	10.7	0.9	24.6 to 28.0

Tests for Homogeneity of Variances

Cochrans C = 0.4057, P = 0.181 (Approx.)

Iowa Tests of Basic Skills

Grade 4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	82.4	41.2	0.80	0.46
Within Groups	156	8031.7	51.5		
Total	158	8114.2			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini E	48	12.1	7.0	1.0	10.1 to 14.2
Math Only	36	13.9	7.5	1.2	11.3 to 16.4
Control	75	13.6	7.1	0.8	11.9 to 15.2
Total	159	13.2	7.2	0.6	12.1 to 14.3

Tests for Homogeneity of Variances

Cochrans C = 0.3602, P = 0.601 (Approx.)

Iowa Tests of Basic Skills [illegible]

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	30.9	15.5	0.32	0.68
Within Groups	152	7349.4	48.4		
Total	154	7380.3			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	44	12.9	5.3	0.8	11.3 to 14.6
Math Only	44	14.1	8.3	1.3	11.6 to 16.6
Control	67	13.6	6.9	0.8	11.9 to 15.3
Total	155	13.6	6.9	0.6	12.5 to 14.7

Tests for Homogeneity of Variances

Cochrans C = 0.475, P = 0.012 (Approx.)

Attitude Toward Math PRE

Grade 4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	63.0	31.5	0.31	0.69
Within Groups	158	16101.2	101.9		
Total	160	16164.2			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	48	51.0	9.5	1.4	48.2 to 53.7
Math Only	37	51.2	11.3	1.9	47.4 to 54.9
Control	76	49.8	9.9	1.1	47.6 to 52.1
Total	161	50.5	10.1	0.8	48.9 to 52.0

Tests for Homogeneity of Variances

Cochrans C = 0.4065, P = 0.172 (Approx.)

Attitude Toward Math PRE

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	416.4	208.2	1.98	0.14
Within Groups	154	16173.3	105.0		
Total	156	16589.8			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	45	46.0	10.1	1.5	42.9 to 49.0
Math Only	44	50.2	10.6	1.6	47.0 to 53.4
Control	68	48.7	10.1	1.2	46.2 to 51.1
Total	157	48.3	10.3	0.8	46.7 to 49.9

Tests for Homogeneity of Variances

Cochrans C = 0.3557, P = 0.662 (Approx.)

Academic Self-Concept PRE

Grade 4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	536.0	268.0	0.82	0.45
Within Groups	158	51826.0	328.0		
Total	160	52362.0			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	49	96.2	18.5	2.6	90.9 to 101.5
Math Only	36	92.2	18.7	3.1	85.9 to 98.5
Control	76	96.8	17.6	2.0	92.7 to 100.8
Total	161	95.6	18.1	1.4	92.8 to 98.4

Tests for Homogeneity of Variances

Cochrans C = 0.3495, P = 0.742 (Approx.)

Academic Self-Concept PRE

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	160.0	80.0	0.21	0.68
Within Groups	153	58021.0	379.2		
Total	155	58181.0			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	44	95.2	21.0	3.2	88.8 to 101.6
Math Only	44	94.7	18.8	2.8	89.0 to 100.4
Control	68	97.0	18.9	2.3	92.4 to 101.5
Total	156	98.8	19.4	1.6	92.8 to 98.9

Tests for Homogeneity of Variances

Cochrans C = 0.3824, P = 0.360 (Approx.)

Math Self-Concept PRE

Grade 4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	37.8	18.9	0.42	0.65
Within Groups	158	7124.6	45.1		
Total	160	7162.3			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	49	25.1	6.1	0.9	23.3 to 26.8
Math Only	36	23.8	7.0	1.2	21.4 to 26.2
Control	76	24.8	7.0	0.8	23.2 to 26.4
Total	161	24.7	6.6	0.5	23.6 to 25.7

Tests for Homogeneity of Variances

Cochrans C = 0.3661, P = 0.524 (Approx.)

Math Self-Concept PRE

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	32.8	16.4	0.37	0.67
Within Groups	153	6803.3	44.5		
Total	155	6836.1			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	44	25.4	7.4	1.1	23.2 to 27.7
Math Only	44	25.8	7.0	1.1	23.6 to 28.0
Control	68	26.5	5.8	0.7	25.1 to 27.9
Total	156	20.0	6.6	0.5	25.0 to 27.1

Tests for Homogeneity of Variances

Cochrans C = 0.3972, P = 0.240 (Approx.)

Locus of Control PRE

Grade 4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	7.5	3.8	0.19	0.67
Within Groups	158	3054.3	19.3		
Total	160	3061.8			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	48	25.9	4.4	0.6	24.6 to 27.2
Math Only	37	26.5	4.1	0.7	25.1 to 27.9
Control	76	26.2	4.5	0.5	25.1 to 27.2
Total	161	26.2	4.4	0.3	25.5 to 26.8

Tests for Homogeneity of Variances

Cochrans C = 0.3609, P = 0.589 (Approx.)

Locus of Control PRE

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	79.8	39.9	1.66	0.19
Within Groups	153	3675.9	24.0		
Total	155	3755.7			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	45	27.8	4.4	0.6	26.6 to 29.1
Math Only	43	25.9	5.9	0.9	24.1 to 27.8
Control	68	27.1	4.8	0.6	25.9 to 28.2
Total	156	27.0	4.9	0.4	26.2 to 27.8

Tests for Homogeneity of Variances

Cochrans C = 0.4689, P = 0.016 (Approx.)

APPENDIX E

Instruments/Psychometrics

The computation section of the Comprehensive Tests of Basic Skills and the Modern Mathematics Supplement to the Iowa Tests of Basic Skills cannot be reproduced in this volume due to copyright laws. However, an example of the type of item contained on each test is presented below.

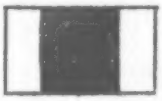
ITBS - Grade 4

What number should replace the box in the number sentence $(2 + 5) = (\square + 3)$?

1) 7
2) 10
3) 2
4) 4

ITBS - Grade 5

What part of this figure is shaded?



1) 2/4
2) 1/4
3) 3/5
4) 3/4

CTBS - Grade 4 & 5

$4\overline{)24}$

A. 6
B. 9
C. 3
D. 5

Grade 4 CTBS PRE

Item	Mean	Std. Dev.	Correl.
1	0.88	0.33	0.373
2.	0.89	0.32	0.318
3	0.83	0.37	0.347
4	0.75	0.44	0.391
5	0.85	0.36	0.288
6	0.81	0.39	0.336
7	0.62	0.49	0.341
8	0.64	0.49	0.447
9	0.72	0.45	0.511
10	0.61	0.49	0.520
11	0.75	0.44	0.548
12	0.64	0.48	0.513
13	0.63	0.48	0.591
14	0.67	0.47	0.552
15	0.57	0.50	0.580
16	0.33	0.47	0.585
17	0.55	0.50	0.605
18	0.51	0.50	0.633
19	0.44	0.50	0.372
20	0.41	0.49	0.598
21	0.43	0.50	0.655
22	0.35	0.48	0.610
23	0.52	0.50	0.709
24	0.28	0.45	0.465
25	0.41	0.49	0.625
26	0.30	0.46	0.622
27	0.30	0.46	0.670
28	0.22	0.41	0.519
29	0.27	0.45	0.616
30	0.17	0.38	0.602
31	0.25	0.43	0.636
32	0.25	0.44	0.576
33	0.15	0.36	0.402
34	0.10	0.30	0.340
35	0.25	0.44	0.658
36	0.09	0.29	0.248
37	0.15	0.36	0.442
38	0.23	0.42	0.477
39	0.16	0.37	0.463
40	0.20	0.40	0.577
41	0.11	0.32	0.267
42	0.13	0.34	0.458
43	0.05	0.22	0.195
44	0.13	0.34	0.362
45	0.09	0.29	0.311
46	0.06	0.24	0.310
47	0.10	0.30	0.279
48	0.09	0.28	0.183

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	162	18.90	9.76	2.55	0.031

Grade 4 CTBS POST

Item	Mean	Std. Dev.	Correl.
1	0.96	0.20	0.320
2	0.92	0.27	0.295
3	0.94	0.24	0.404
4	0.80	0.40	0.354
5	0.85	0.36	0.435
6	0.80	0.40	0.464
7	0.74	0.44	0.433
8	0.74	0.44	0.371
9	0.83	0.38	0.517
10	0.75	0.44	0.491
11	0.78	0.42	0.417
12	0.77	0.43	0.448
13	0.77	0.42	0.563
14	0.78	0.41	0.577
15	0.75	0.44	0.534
16	0.64	0.48	0.675
17	0.67	0.47	0.498
18	0.77	0.42	0.519
19	0.64	0.48	0.453
20	0.59	0.49	0.575
21	0.64	0.48	0.672
22	0.46	0.50	0.595
23	0.65	0.48	0.740
24	0.40	0.49	0.514
25	0.62	0.49	0.761
26	0.48	0.50	0.579
27	0.57	0.50	0.649
28	0.44	0.50	0.667
29	0.48	0.50	0.695
30	0.44	0.50	0.658
31	0.46	0.50	0.698
32	0.47	0.50	0.698
33	0.29	0.46	0.461
34	0.17	0.37	0.179
35	0.41	0.49	0.699
36	0.25	0.43	0.259
37	0.24	0.43	0.418
38	0.32	0.47	0.622
39	0.32	0.47	0.536
40	0.38	0.49	0.746
41	0.26	0.44	0.502
42	0.23	0.43	0.451
43	0.12	0.33	0.347
44	0.39	0.49	0.533
45	0.24	0.43	0.472
46	0.19	0.39	0.291
47	0.25	0.43	0.390
48	0.15	0.36	0.316

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	162	25.95	11.01	2.63	0.943

Grade 5 CTBS PRE

Item	Mean	Std. Dev.	Correl.
1	0.91	0.29	0.397
2	0.89	0.31	0.404
3	0.87	0.34	0.336
4	0.77	0.42	0.460
5	0.85	0.36	0.334
6	0.84	0.37	0.467
7	0.68	0.47	0.441
8	0.69	0.46	0.568
9	0.78	0.41	0.556
10	0.69	0.46	0.553
11	0.78	0.41	0.580
12	0.72	0.45	0.561
13	0.77	0.42	0.583
14	0.78	0.42	0.603
15	0.80	0.40	0.562
16	0.62	0.49	0.615
17	0.66	0.48	0.458
18	0.77	0.42	0.589
19	0.61	0.49	0.502
20	0.61	0.49	0.415
21	0.65	0.48	0.647
22	0.49	0.50	0.648
23	0.67	0.47	0.672
24	0.51	0.50	0.527
25	0.64	0.48	0.667
26	0.54	0.50	0.578
27	0.53	0.50	0.667
28	0.47	0.50	0.549
29	0.53	0.50	0.610
30	0.41	0.49	0.525
31	0.49	0.50	0.566
32	0.49	0.50	0.643
33	0.36	0.48	0.316
34	0.20	0.40	0.196
35	0.47	0.50	0.620
36	0.25	0.44	0.116
37	0.31	0.46	0.370
38	0.41	0.49	0.577
39	0.35	0.48	0.524
40	0.46	0.50	0.581
41	0.33	0.47	0.521
42	0.22	0.42	0.358
43	0.15	0.36	0.152
44	0.26	0.44	0.403
45	0.29	0.46	0.573
46	0.18	0.39	0.234
47	0.27	0.45	0.339
48	0.25	0.44	0.267

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	158	26.27	10.70	2.74	0.935

Grade 5 CTBS POST

Item	Mean	Std. Dev.	Correl.
1	0.92	0.27	0.500
2	0.89	0.32	0.390
3	0.90	0.30	0.480
4	0.77	0.42	0.537
5	0.86	0.35	0.486
6	0.77	0.42	0.612
7	0.68	0.47	0.576
8	0.65	0.48	0.572
9	0.81	0.39	0.581
10	0.77	0.42	0.542
11	0.78	0.42	0.681
12	0.71	0.46	0.597
13	0.82	0.39	0.552
14	0.84	0.37	0.593
15	0.70	0.46	0.635
16	0.71	0.46	0.629
17	0.67	0.47	0.484
18	0.70	0.46	0.600
19	0.60	0.49	0.458
20	0.59	0.49	0.550
21	0.57	0.50	0.726
22	0.46	0.50	0.652
23	0.65	0.48	0.675
24	0.52	0.50	0.414
25	0.56	0.50	0.729
26	0.56	0.50	0.581
27	0.61	0.49	0.513
28	0.60	0.49	0.545
29	0.58	0.50	0.507
30	0.54	0.50	0.614
31	0.60	0.49	0.636
32	0.58	0.50	0.491
33	0.45	0.50	0.353
34	0.28	0.45	0.312
35	0.53	0.50	0.607
36	0.40	0.49	0.336
37	0.40	0.49	0.360
38	0.53	0.50	0.554
39	0.51	0.50	0.525
40	0.51	0.50	0.577
41	0.42	0.50	0.386
42	0.30	0.46	0.295
43	0.20	0.40	0.262
44	0.49	0.50	0.487
45	0.30	0.46	0.461
46	0.23	0.42	0.304
47	0.36	0.48	0.519
48	0.29	0.46	0.293

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	158	28.13	11.36	2.75	0.941

Grade 4 ITBS PRE

Item	Mean	Std. Dev.	Correl.
1	0.67	0.47	0.234
2	0.56	0.50	0.055
3	0.70	0.46	0.206
4	0.50	0.50	0.381
5	0.65	0.48	0.432
6	0.54	0.50	0.438
7	0.67	0.47	0.528
8	0.56	0.50	0.448
9	0.35	0.48	0.551
10	0.48	0.50	0.526
11	0.36	0.48	0.498
12	0.40	0.50	0.426
13	0.52	0.50	0.569
14	0.38	0.49	0.474
15	0.43	0.50	0.613
16	0.48	0.50	0.511
17	0.20	0.40	0.463
18	0.31	0.46	0.498
19	0.24	0.43	0.370
20	0.30	0.46	0.385
21	0.12	0.33	0.268
22	0.22	0.42	0.494
23	0.31	0.46	0.575
24	0.27	0.44	0.404
25	0.17	0.38	0.410
26	0.35	0.48	0.544
27	0.31	0.47	0.644
28	0.20	0.40	0.566
29	0.23	0 42	0.495
30	0.36	0.48	0.643
31	0.17	0.38	0.618
32	0.16	0.37	0.292
33	0.24	0.43	0.346
34	0.24	0.43	0.413
35	0.16	0.37	0.443
36	0.15	0.36	0.289

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	162	12.96	7.32	2.46	0.887

Grade 4 ITBS POST

Item	Mean	Std. Dev.	Correl.
1	0.52	0.50	0.381
2	0.70	0.46	0.395
3	0.75	0.44	0.482
4	0.52	0.50	0.468
5	0.69	0.46	0.486
6	0.69	0.47	0.555
7	0.74	0.44	0.496
8	0.65	0.48	0.507
9	0.44	0.50	0.470
10	0.66	0.48	0.391
11	0.34	0.48	0.564
12	0.48	0.50	0.403
13	0.62	0.49	0.555
14	0.36	0.48	0.543
15	0.57	0.50	0.614
16	0.66	0.48	0.614
17	0.27	0.44	0.442
18	0.53	0.50	0.588
19	0.36	0.48	0.368
20	0.34	0.48	0.363
21	0.26	0.44	0.506
22	0.44	0.50	0.533
23	0.56	0.50	0.586
24	0.49	0.50	0.539
25	0.50	0.50	0.438
26	0.50	0.50	0.624
27	0.49	0.50	0.632
28	0.38	0.49	0.430
29	0.33	0.47	0.593
30	0.55	0.50	0.610
31	0.35	0.48	0.618
32	0.22	0.42	0.334
33	0.40	0.49	0.432
34	0.33	0.47	0.524
35	0.27	0.44	0.550
36	0.21	0.41	0.356

TOTAL SCALE	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
	162	16.99	8.61	2.50	0.915

Grade 5 ITBS PRE

Item	Mean	Std. Dev.	Correl.
1	0.63	0.49	0.405
2	0.27	0.45	0.342
3	0.55	0.50	0.514
4	0.27	0.44	0.470
5	0.34	0.47	0.345
6	0.23	0.42	0.347
7	0.36	0.48	0.376
8	0.50	0.50	0.499
9	0.51	0.50	0.509
10	0.30	0.46	0.395
11	0.54	0.50	0.528
12	0.49	0.50	0.555
13	0.44	0.50	0.427
14	0.30	0.46	0.391
15	0.54	0.50	0.632
16	0.34	0.48	0.565
17	0.30	0.46	0.215
18	0.48	0.50	0.408
19	0.31	0.46	0.408
20	0.35	0.48	0.425
21	0.25	0.43	0.160
22	0.32	0.47	0.338
23	0.40	0.49	0.519
24	0.24	0.43	0.413
25	0.35	0.48	0.380
26	0.25	0.43	0.305
27	0.89	0.39	0.007
28	0.40	0.49	0.479
29	0.31	0.46	0.568
30	0.35	0.48	0.502
31	0.20	0.40	0.428
32	0.17	0.38	0.246
33	0.24	0.43	0.358
34	0.35	0.43	0.227
35	0.16	0.37	0.205
36	0.31	0.41	0.176
37	0.16	0.37	0.378
38	0.20	0.40	0.350
39	0.18	0.39	0.141
40	0.15	0.35	0.063
41	0.09	0.29	0.195
42	0.17	0.38	0.215

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	158	13.27	7.10	2.72	0.853

Grade 5 ITBS POST

Item	Mean	Std.Dev.	Correl.
1	0.70	0.46	0.343
2	0.37	0.49	0.396
3	0.61	0.49	0.312
4	0.45	0.50	0.200
5	0.31	0.46	0.452
6	0.30	0.46	0.358
7	0.57	0.50	0.493
8	0.76	0.43	0.487
9	0.60	0.49	0.487
10	0.33	0.47	0.479
11	0.64	0.48	0.502
12	0.62	0.49	0.522
13	0.46	0.50	0.536
14	0.28	0.45	0.446
15	0.62	0.49	0.500
16	0.54	0.50	0.523
17	0.34	0.48	0.098
18	0.59	0.49	0.397
19	0.38	0.49	0.558
20	0.49	0.50	0.578
21	0.30	0.46	0.374
22	0.42	0.50	0.596
23	0.51	0.50	0.569
24	0.30	0.46	0.468
25	0.40	0.49	0.475
26	0.29	0.46	0.250
27	0.25	0.43	0.270
28	0.49	0.50	0.534
29	0.37	0.48	0.547
30	0.40	0.49	0.468
31	0.22	0.41	0.363
32	0.27	0.44	0.131
33	0.41	0.49	0.413
34	0.41	0.49	0.235
35	0.27	0.44	0.162
36	0.31	0.46	0.412
37	0.30	0.46	0.462
38	0.32	0.47	0.273
39	0.22	0.42	0.314
40	0.23	0.42	0.172
41	0.19	0.39	0.226
42	0.25	0.44	0.184

TOTAL	N	Mean	Std.Dev.	Std. Error Meas.	Alpha
SCALE	158	17.09	7.80	2.84	0.868

Attitudes About Math

This is not a test. There are no right or wrong answers. We are just interested in finding out how you feel about Math.

Read the statements on the following pages. Decide whether you agree with each statement all the time, most of the time, some of the time, or never. Then put a mark in the column on your answer sheet which best describes how you feel about each statement. Read silently along with the teacher and practice on the examples below.

A. Doing math problems is easy.

B. When I study I do well in math.

C. Doing word problems is exciting.

Remember:

- Tell us how you feel about math by marking each column on your answer sheet as honestly as you can.
- Put only one mark in one column for each statement.
- Put all your answers on your answer sheet.

Attitudes About Math

1. Working with numbers is fun.
2. Math should be avoided whenever possible.
†3. I think that kids who work hard do well in math.
4. Discovering the solutions to mathematics problems is exciting.
†5. When I'm told my math work is good, it's because I'm really doing a good job in math.
6. Math is good because it makes you think.
7. It is fun to think about Math problems outside of class.
†8. When I can work my math problems, it's because I understand how to do the problems very well.
9. Word problems are frustrating.
*10. I think I get my math grades just by accident.
11. Doing math problems is boring.
12. One cannot use mathematics in daily life.
*13. When I get bad grades in math, it's because the work is too hard for me.
14. Math is very interesting.
*15. When I can work my math problems, it's just a lucky day for me.
16. Discovering solutions to mathematics problems is frustrating.
17. Mathematics is a stimulating activity.
†18. When I get good grades in Math, it's because I work hard in math class.
19. Mathematics is too complicated.
*20. I get low marks in math even when I study hard.
21. Math is logical.
22. Math is necessary in daily life.

*23. When I'm told my math work is good, it's just to make me feel better.

24. There are too many steps needed in getting the answer to a problem.

25. There are too many chances to make a mistake in math.

27. Math is practical.

*28. When I get bad grades in math, it's because nobody will help me with my work.

29. Mathematics takes too long.

*30. Math tests are just a lot of guess work for me.

31. Most word problems are not practical.

32. Mathematics is frightening.

33. Math is a waste of time.

†34. When I do well on a math test, it's because I work on it very carefully.

35. It is fun to play with numbers.

*36. When I can work my math problems, it's because the problems are especially easy to do.

37. There are too many rules to learn in math.

38. Discovering the solutions to mathematics problems is rewarding.

*39. When I don't do well in math class, it's someone else's fault.

*Items appear on the External Locus of Control Scale (Feelings About Math)
†Items appear on the Internal Locus of Control Scale (Fellings About Math)

All remaining items are on the Attitude Toward Mathematics Scale

Standard Definitions Given by Examiners for Difficult Terms Found in the Dutton-Likert Scale

Item Number	Term	Definition
2	avoided	keep away or get away from
4	solutions	answers
9, 16	frustrating	bothers you; gives you trouble; makes you nervous
11	boring	no fun; makes you tired
12, 22	daily	happens every day
17	stimulating	exciting; fun; want to do more
19	complicated	hard; not easy to do
21	logical	makes sense; easy to understand
27, 31	practical	you can use it; helpful
32	frightening	scary; makes you afraid or scared
38	rewarding	feel like you've earned something; like a good feeling after working hard on something

Grade 4 Attitude Towards Math PRE

Item	Mean	Std. Dev.	Correl.
1	2.08	0.93	0.491
2	1.89	1.03	0.356
3	2.27	0.93	0.394
4	1.76	0.94	0.479
5	2.90	0.99	0.301
6	2.07	1.03	0.466
7	2.13	1.08	0.657
8	2.30	1.10	0.235
9	2.04	1.06	0.562
10	2.16	0.99	0.558
11	2.29	1.04	0.490
12	2.10	0.90	0.413
13	1.99	0.96	0.479
14	2.04	1.03	0.258
15	2.15	0.87	0.550
16	2.16	0.82	0.439
17	2.01	0.96	0.401
18	2.28	0.98	0.582
19	2.01	0.82	0.225
20	1.57	0.88	0.390
21	1.69	0.95	0.440
22	2.15	1.00	0.449
23	2.29	0.97	0.470
24	2.25	1.02	0.265

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	161	50.47	10.05	4.39	0.809

Grade 4 Attitude Towards Math POST

Item	Mean	Std. Dev.	Correl.
1	2.23	0.90	0.530
2	1.90	1.02	0.427
3	2.38	1.01	0.468
4	1.78	0.92	0.492
5	2.69	1.03	0.428
6	2.14	0.94	0.548
7	2.09	1.04	0.690
8	1.92	1.01	0.259
9	2.07	1.05	0.670
10	1.97	0.83	0.416
11	2.44	1.04	0.622
12	1.96	0.83	0.582
13	2.01	0.97	0.512
14	1.90	0.97	0.348
15	2.20	0.90	0.438
16	2.24	0.83	0.392
17	1.87	0.93	0.378
18	2.14	0.88	0.606
19	2.13	0.95	0.381
20	1.58	0.92	0.387
21	1.56	0.91	0.614
22	2.19	0.97	0.469
23	2.07	0.91	0.520
24	2.32	1.06	0.432

TOTAL	N	Mean	Std. Dev.	Std. Error Mean	Alpha
SCALE	160	49.79	11.05	4.18	0.867

Grade 6 Attitude Towards Math PRE

Item	Mean	Std. Dev.	Correl.
1	2.04	0.84	0.498
2	1.99	1.00	0.373
3	2.12	0.93	0.488
4	1.74	0.91	0.529
5	2.66	1.09	0.312
6	2.08	0.89	0.345
7	1.95	0.99	0.624
8	2.07	1.03	0.183
9	1.93	1.01	0.631
10	2.06	0.87	0.573
11	2.42	0.97	0.564
12	2.01	0.83	0.520
13	1.75	0.94	0.380
14	1.76	0.90	0.449
15	2.22	0.85	0.386
16	2.25	0.82	0.372
17	1.80	0.85	0.487
18	2.24	0.95	0.651
19	2.04	0.89	0.440
20	1.42	0.77	0.411
21	1.56	0.94	0.528
22	2.11	0.97	0.582
23	2.12	0.98	0.423
24	1.98	0.98	0.414

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	157	48.32	10.31	4.11	0.841

Grade 6 Attitude towards Math POST

Item	Mean	Std. Dev.	Correl.
1	2.10	0.84	0.384
2	1.82	0.95	0.416
3	2.15	0.90	0.490
4	1.71	0.82	0.399
5	2.66	1.00	0.292
6	2.12	0.82	0.301
7	2.02	0.97	0.567
8	1.99	1.14	0.181
9	2.18	0.99	0.565
10	1.95	0.77	0.579
11	2.42	0.91	0.539
12	2.00	0.87	0.624
13	1.87	0.91	0.614
14	1.70	0.99	0.472
15	2.24	0.85	0.318
16	2.23	0.84	0.425
17	1.73	0.84	0.558
18	2.10	0.87	0.548
19	1.87	0.83	0.269
20	1.45	0.81	0.526
21	1.42	0.81	0.618
22	2.21	1.00	0.548
23	2.18	0.97	0.614
24	1.95	0.95	0.397

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	154	48.08	10.07	4.02	0.841

Grade 4 External Locus of Control PRE

Item	Mean	Std. Dev.	Correl.
1	3.11	0.98	0.481
2	2.82	0.79	0.419
3	2.49	1.01	0.542
4	3.00	0.85	0.489
5	2.63	1.12	0.630
6	3.16	1.02	0.556
7	3.07	0.95	0.533
8	2.42	0.95	0.464
9	3.47	0.91	0.441

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	161	26.16	4.37	2.62	0.642

Grade 4 External Locus of Control POST

Item	Mean	Std. Dev.	Correl.
1	3.30	0.85	0.544
2	2.99	0.87	0.492
3	2.83	1.04	0.409
4	2.99	0.87	0.546
5	2.82	1.08	0.866
6	3.29	0.87	0.538
7	3.24	0.94	0.382
8	2.54	0.94	0.382
9	3.59	0.83	0.381

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	160	27.59	4.29	2.52	0.655

Grade 5 External Locus of Control PRE

Item	Mean	Std. Dev.	Correl.
1	3.31	0.97	0.694
2	2.83	0.88	0.432
3	2.61	1.11	0.629
4	3.06	0.88	0.546
5	2.81	1.12	0.527
6	3.27	0.83	0.508
7	3.23	0.99	0.665
8	2.44	0.94	0.464
9	3.43	0.95	0.614

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	156	26.99	4.92	2.54	0.734

Grade 5 External Locus of Control POST

Item	Mean	Std. Dev.	Correl.
1	3.39	0.86	0.609
2	2.89	0.87	0.350
3	3.06	1.12	0.606
4	3.23	0.78	0.632
5	3.12	1.02	0.558
6	3.28	0.90	0.599
7	3.27	0.89	0.570
8	2.55	0.95	0.475
9	3.68	0.69	0.435

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	154	28.47	4.37	2.43	0.690

About Myself

Some girls and boys have thought about the things they do and decided that the items on these pages were helpful in thinking about themselves. This is a chance for you to look at yourself and decide what your strong points are and what your weak points are. This is not a test: we expect everyone to have different answers--so be sure your answers show how you think about yourself. Your answers are private and will be kept in confidence.

Read each item silently as the teacher reads it to the class. Then answer the question: Compared with other boys and girls my age, how do I rate now?

On your answer sheet, find the line under the heading hat indicates your answer. The words at the top show what the linesin each column stand for. Put a mark in the box under the heading yo choose.

Now go right ahead, silently reading along with the tecner.

About Myself

1. Learning things rapidly

*2. Solving word problems

3. Having new, original ideas

4. Setting my school work done on time and not getting behind

5. Being able to read well

6. Remembering what I've learned

*7. Being interested in math; learning about different kinds of measuring systems

8. Solving problems in ways others haven't tried

9. Knowing how to do math

10. Being a good student

*11. Learning how to multiply rapidly

12. Thinking up answers to problems--answers no one else has thought of

13. Being able to concentrate

14. Being interested in science--learning about things that scientists do

15. Having brains for college

*16. Remembering what I've learned about sets and subsets

17. Learning about new things even when other people aren't interested--studying about things on my own

18. Writing creative stories and poems

19. Being able to apply what I've learned

*20. Being good at measuring length and width

21. Seeing new ways of thinking about things and putting ideas together

22. Spending most of my time on my work, not goofing off

23. Having good handwriting even when I'm hurried

24. Having brains

*25. Being able to do subtraction problems correctly

26. Being able to see things in my mind easily when I want to

27. Being able to spell correctly

28. Being smart

*29. Knowing how to do one digit division problems correctly

30. Being interested in new things; excited about all there is to learn

31. Being well organized; having materials ready when needed

32. Learning about people around the world and being interested in them

33. Knowing what to do to get the right answer to a problem

*34. Learning about fractions

35. Letting my imagination go when I want to

36. Doing well in art work, painting, or drawing

*Items appear on the Mathematics Self-Concept Scale. All others are a part of the Academic Self-Concept Scale.

Grade 4 Academic Self-Concept PRE

Item	Mean	Std. Dev.	Correl.
1	2.98	1.29	0.532
2	3.01	1.32	0.392
3	3.23	1.39	0.443
4	3.62	1.33	0.487
5	3.31	1.34	0.451
6	2.96	1.26	0.558
7	3.51	1.25	0.465
8	3.56	1.26	0.513
9	2.92	1.24	0.368
10	3.34	1.42	0.578
11	3.27	1.49	0.469
12	3.36	1.38	0.392
13	3.41	1.32	0.588
14	3.22	1.49	0.343
15	3.41	1.21	0.544
16	3.21	1.30	0.523
17	3.47	1.40	0.480
18	3.25	1.53	0.478
19	3.84	1.21	0.527
20	3.56	1.27	0.506
21	3.72	1.35	0.589
22	3.66	1.34	0.618
23	3.69	1.27	0.406
24	3.39	1.32	0.502
25	3.61	1.26	0.417
26	3.49	1.27	0.561
27	3.57	1.32	0.397
28	4.00	1.30	0.367

TOTAL SCALE	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
	161	95.58	18.09	6.25	0.881

Grade 4 Academic Self-Concept POST

Item	Mean	Std. Dev.	Correl.
1	3.04	1.23	0.684
2	3.21	1.30	0.568
3	3.37	1.37	0.530
4	3.88	1.19	0.513
5	3.24	1.29	0.587
6	2.87	1.27	0.622
7	3.64	1.24	0.590
8	3.58	1.34	0.495
9	3.04	1.27	0.574
10	3.31	1.30	0.636
11	3.33	1.46	0.503
12	3.26	1.30	0.613
13	3.47	1.31	0.514
14	3.14	1.48	0.454
15	3.51	1.21	0.713
16	3.18	1.25	0.581
17	3.27	1.41	0.544
18	2.99	1.44	0.454
19	3.73	1.27	0.621
20	3.30	1.31	0.513
21	3.50	1.28	0.532
22	3.45	1.36	0.713
23	3.53	1.28	0.550
24	3.28	1.31	0.650
25	3.38	1.38	0.539
26	3.49	1.23	0.703
27	3.51	1.40	0.554
28	3.90	1.35	0.341

TOTAL SCALE	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
	157	94.38	20.84	5.87	0.921

Grade 5 Academic Self-Concept PRE

Item	Mean	Std. Dev.	Correl.
1	3.23	1.23	0.625
2	3.09	1.21	0.466
3	3.25	1.44	0.444
4	3.73	1.29	0.622
5	3.40	1.19	0.604
6	2.88	1.21	0.536
7	3.60	1.20	0.378
8	3.78	1.21	0.511
9	2.93	1.28	0.547
10	3.48	1.26	0.602
11	3.18	1.54	0.359
12	3.22	1.35	0.568
13	3.46	1.31	0.601
14	3.44	1.47	0.468
15	3.51	1.10	0.608
16	3.28	1.29	0.611
17	3.54	1.22	0.554
18	2.82	1.47	0.522
19	3.64	1.34	0.519
20	3.62	1.38	0.573
21	3.49	1.38	0.588
22	3.69	1.25	0.603
23	3.64	1.18	0.512
24	3.47	1.26	0.559
25	3.40	1.29	0.596
26	3.44	1.33	0.508
27	3.71	1.31	0.500
28	3.91	1.34	0.411

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	156	95.83	19.37	5.94	0.906

Grade 5 Academic Self-Concept POST

Item	Mean	Std. Dev.	Correl.
1	3.26	1.18	0.624
2	3.13	1.29	0.620
3	3.47	1.41	0.590
4	3.70	1.36	0.583
5	3.59	1.10	0.627
6	3.08	1.23	0.598
7	3.75	1.21	0.577
8	3.71	1.25	0.692
9	2.90	1.21	0.618
10	3.53	1.28	0.693
11	3.03	1.53	0.567
12	3.36	1.34	0.639
13	3.67	1.19	0.715
14	3.37	1.51	0.449
15	3.59	1.05	0.672
16	3.29	1.20	0.723
17	3.47	1.32	0.675
18	2.89	1.42	0.552
19	3.67	1.32	0.721
20	3.73	1.17	0.590
21	3.50	1.38	0.641
22	3.73	1.23	0.726
23	3.72	1.17	0.640
24	3.56	1.21	0.599
25	3.49	1.37	0.650
26	3.52	1.19	0.642
27	3.54	1.38	0.546
28	3.80	1.40	0.265

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	157	97.05	21.97	5.50	0.937

Grade 4 Math Self-Concept PRE

Item	Mean	Std. Dev.	Correl.
1	3.05	1.33	0.537
2	2.86	1.37	0.678
3	2.99	1.40	0.692
4	3.04	1.35	0.541
5	2.90	1.48	0.511
6	3.77	1.30	0.556
7	3.15	1.46	0.673
8	2.90	1.40	0.634

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	161	24.65	6.69	3.35	0.750

Grade 4 Math Self-Concept POST

Item	Mean	Std. Dev.	Correl.
1	3.10	1.27	0.593
2	3.17	1.34	0.686
3	3.52	1.38	0.650
4	3.31	1.32	0.636
5	2.94	1.38	0.673
6	3.32	1.23	0.576
7	3.63	1.34	0.669
8	3.47	1.34	0.608

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	157	26.96	6.76	3.09	0.791

Grade 5 Math Self-Concept PRE

Item	Mean	Std. Dev.	Correl.
1	3.06	1.22	0.542
2	3.09	1.36	0.659
3	3.36	1.42	0.694
4	3.35	1.35	0.526
5	2.83	1.34	0.519
6	3.74	1.31	0.649
7	3.51	1.43	0.714
8	3.07	1.33	0.619

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	156	26.01	6.64	3.20	0.767

Grade 5 Math Self-Concept POST

Item	Mean	Std. Dev.	Correl.
1	3.27	1.24	0.639
2	3.22	1.29	0.597
3	3.63	1.31	0.757
4	3.27	1.32	0.674
5	2.99	1.28	0.640
6	4.00	1.24	0.726
7	3.89	1.36	0.763
8	3.70	1.28	0.722

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	157	27.97	7.13	2.83	0.843

APPENDIX F

Observer Training Manual

OBSERVER TRAINING MANUAL

In this study, observers will collect information about the use of diagnostic questions, demonstration techniques, praise and criticism in a tutoring session. An observer, trained to identify specific tutoring techniques, will sit in the classroom during a tutoring session. The observer will use a sequence line to score each instance of a technique as it occurs.

Of the material which follows, much has been taken from the Mini-course 5 Teacher Handbook. This material is set off by quotation marks. Most of the remaining material comes from Gall and Stowitschek who developed procedures for training critiquers.

FIRST TRAINING SESSION

In a tutoring session, teachers will generally follow a basic sequence of four steps:

1. Diagnosis
2. Demonstration
3. Evaluation
4. Practice

In this training session, you will learn five question types a teacher may use to find out what specific problem(s) a student is having in math. These five diagnostic questions constitute the major part of the diagnostic step in the sequence, but may occur throughout the tutoring session.

Definition

Diagnostic questions test the student's understanding of concepts and procedures necessary for the solution of a particular problem. Diagnostic questions may be phrased in either statement or question form.

TYPE 1 - GENERAL

"Pupils with math problems usually confront you with one of two situations. Either they have solved an example incorrectly and cannot locate their error, or they are stuck on an example and cannot arrive at an answer."

"As an illustration of the first situation, suppose that a pupil comes to you with this example, marked wrong":

$$\begin{array}{r} 100 \\ -48 \\ \hline 62 \end{array}$$

"What should your response be? As we pointed out above, it is important that the pupil do the work rather than the teacher. Therefore, rather than telling him what you think he did wrong, ask him, "How did you get your answer?" or "Can you tell me what you did?"

"Now, suppose the pupil comes to you with the same example but has no answer at all, not even an incorrect one. To help this pupil verbalize his difficulty, ask, "What part don't you understand?" or "What is giving you difficulty?"

"After asking one of these general diagnostic questions, you are in a good position to pinpoint the nature of the difficulty. As the pupil explains why he cannot solve the example or how he solved it incorrectly, you can use this information to ask more specific diagnostic questions. These questions often begin with "Why..." or "How..." Once you have found specific weaknesses, then the demonstration phase can be initiated to correct these weaknesses."

For scoring, we define TYPE 1 questions as broad questions which ask the student to verbalize the nature of his problem-solving difficulty. The following are examples of TYPE 1 questions:

(a) What's wrong?
What is the problem?
What part don't you understand?
Can you tell me what you did?
What part is giving you difficulty?
How did you get your answer?
Tell me what you are doing.
Do you see what's wrong?
Can you show me what you have done?

(b) Questions of the "How did you?", "What did you?, "Why did you?" and "Where did you?" form which deal with specific operations or computations which the student has performed. Questions stated in one of these forms should be scored as general diagnostic questions only if they do not clearly fall into one of the other categories.

TYPE 2 - READING

One of the most frequent difficulties students have with verbal reasoning problems is inability to read the problem. Particularly important is knowledge of mathematical and quantitative vocabulary. For scoring, TYPE 2 questions are those that test the student's ability to read the problem and are used primarily in verbal reasoning problems.

Examples:

Can you read the problem for me?
Read this number sentence.
What does this equation say?

TYPE 3 - DEFINITION

Questions that test the student's understanding of word definitions are TYPE 3. Again, used primarily with verbal reasoning problems.

Examples:

Are there words you don't know?
Do you know what a mixed number is?
What is a simple fraction?
What does this sign tell us?

TYPE 4 - NUMBER CONCEPT

"Several concepts are basic to an understanding of the number operations of addition, subtraction, multiplication, and division. Perhaps the most important of these are the base ten numeration system, place value, regrouping, and renaming. If the pupil does not understand these concepts, he may be able to perform the standard computational algorithms, but he will not understand what he is doing. For example, if he is asked to solve this example,

$$\begin{array}{r} 32 \\ -7 \\ \hline \end{array}$$

he will need to understand how 3 tens can be renamed as 2 tens + 10 ones, and next how 10 ones can be regrouped (what teachers used to call borrowing or carrying) [and many still do] so that we can write 32 as 2 tens + 12 ones. Essential, too, is an understanding of place value. As we move each column (or place) to the left of the decimal point, the value of the number in that column is multiplied by 10. Thus, 32 can be written as 3 tens plus 2 ones, and 132 can be written as 1 hundred + 3 tens + 2 ones."

Examples of questions that ask students to demonstrate understanding of number concept are:

1. Can you give me another name for 37?
2. What is the value of 4 in the numeral 46?
3. How did you get the 2 in your answer?
4. Why can you write 23 as 0 tens + 13 ones?
5. Why did you bring the 1 in the first column of your answer over to the second column?

For scoring, we define TYPE 4 questions as questions that test the student's understanding of place value, regrouping, and renaming, typically used in addition, subtraction, multiplication, and division. To score a question as TYPE 4, it should be clear to the student what the teacher is asking. "What does this number mean?" is not as clear as "Can you give me another name for 37?"

Examples:

(a) Place value: questions which require the student to explain place value or to demonstrate an understanding of place value.

What is the value of 4 in the numeral 46?
What does the numeral 3 stand for in 356?

(b) Renaming: questions which require the student to rename--a verbal form of expanded notation almost.

Can you give me another name for 37?
Can you rename 51?

(c) Regrouping: the process which was formerly called borrowing. It is used in subtraction and consists of the modifications that must be performed in order to subtract a larger number from a smaller number.

Can you explain how to regroup the number?
Why can't you subtract these numbers the way they are?
Regroup 103 so that we can subtract 57 from it.

TYPE 5 - NUMBER OPERATIONS

"Many pupils have difficulty organizing the information in a verbal reasoning problem so that the appropriate number operation can be selected and applied. Therefore, one of your diagnostic questions should be "What number operation do you use to solve the problem?" If the student does not know how to organize the information in the problem to select the appropriate number operation, then you will develop this skill in the demonstration phase of the basic tutoring sequence."

For scoring, these questions are those in which the teacher asks the student what number operation he would use. The words number operation or a specific number operation should be included in the question.

Examples:

(a) What number operation would you use?
Would you add?

Do not score general questions as number operations or TYPE 5.
What kind of problem is this?
How do you think we solve this problem?

(b) Follow-up questions which ask the student to explain why he selected a particular number operation.
Why did you say we should add?
Why are you going to multiply?

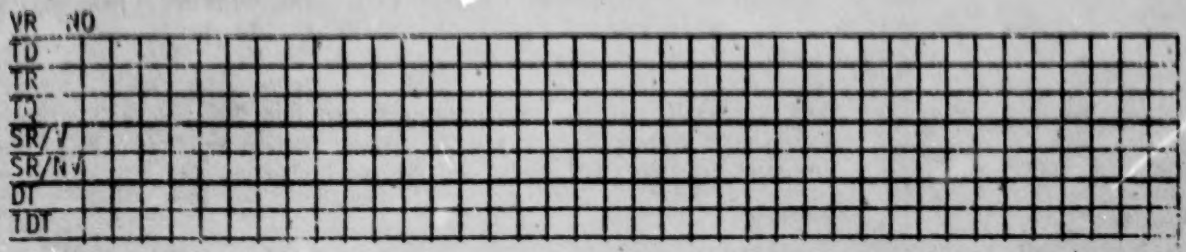
Most of these questions occur with verbal problems. However, they sometimes occur with number operations (e.g. "What's a short form of adding? How can we check our subtraction?") where it is necessary for the student to select a particular number operation.

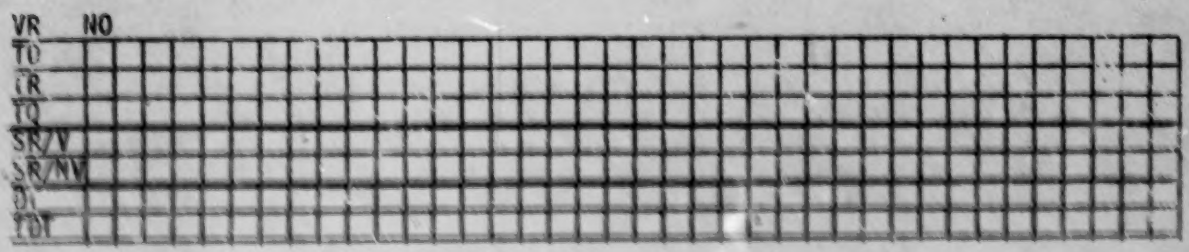
At this point, the trainees will be introduced to the observer rating forms and the sequence line in detail. They will score two tapes for question types only--one tape will be a verbal reasoning problem and the other will be a number operations problem. Ground rules for question types will be established.

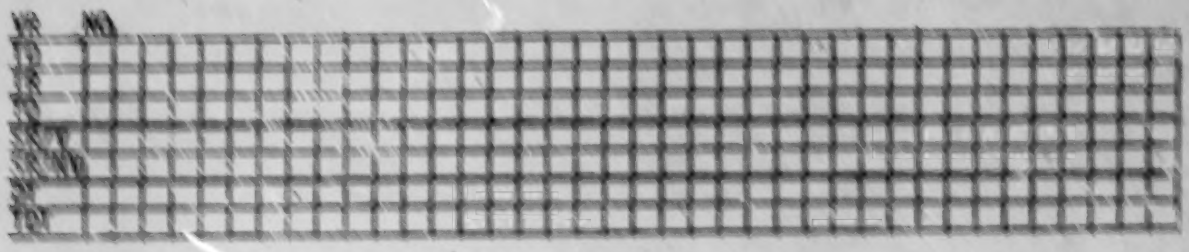
198 OBSERVER FORM

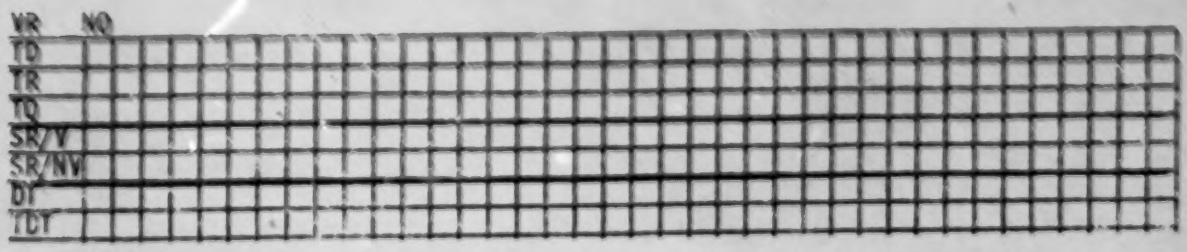
Teacher_____ Student_____

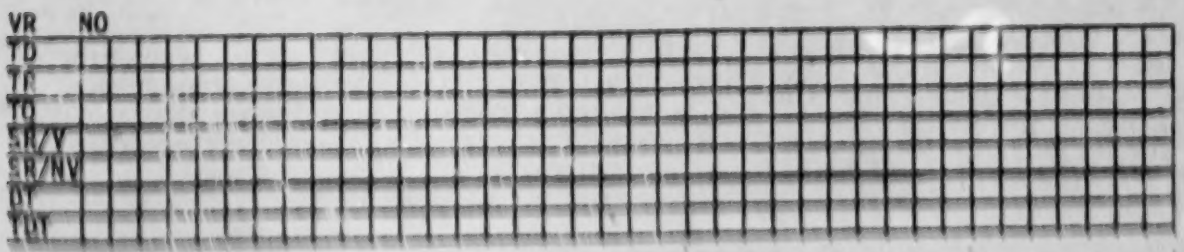
Observer_____ Date_____











Interruptions_____

Evaluation? YES NO Practice Problems YES NO

Motivating Statement? YES NO Warmth/Rapport 1 2 3 4 5 6 7 8 9

OBSERVER FORM

Teacher_____ Date_____

Student_____ Observer_____

Problem_____ NO VR

Evaluation?____ Practice Problems?____ Motivating Statement?____

Warmth/Rapport____ Interruptio____

QUESTIONS

Total____

Type 1____

Type 2____

Type 3____

Type 4____

Type 5____

Type 6____

DEMONSTRATION TECHNIQUES

Instances of:

Estimation____

Diagrams/Pictures____

Number Sentences____

Expanded Notation____

Manipulatives____

Total Seconds

_____

_____

_____

COMMENTS:_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

SECOND TRAINING SESSION

In this session, we'll discuss prompting questions and teacher declarative statements.

PROMPTING

A prompting question gets the student--not the teacher--to perform an operation, or discover a procedure or solution; that is, the student plays an active role in organizing and using knowledge. All questions in a tutoring session which attempt to get the student to perform an activity, make a judgment or decision, or answer a question are essentially prompting. In the general category of prompting questions, we have defined five types. Those five types were presented in the first training session. Most of the other questions (not one of the five types) which occur during a tutoring session will be classified as prompting questions. These are questions which ask the student to do or say something, or perform an activity, and they cannot be classified as one of the other types.

Examples:

Would you count the number of inches in one foot, please?
You're adding how many to six?
What would be the first equivalent?
How many 24ths would be the equivalent of 3/8?
Would you write them down and add them up please?
How much were they going to sell each ticket for?

DECLARATIVE STATEMENTS

Declarative statements provide the student with problem-solving information which a teacher might have obtained by asking the student a question.

Examples:

Mary, 5 times 6 is 30.
You have to take one from the tens column and regroup it.
When you multiply two digit numbers, you have to think about place value.
This is the way you do it. You divide 1200 by 10.
Two-fifths and 1/4 can be added if we change both fractions to twentieths.
Take our answer and our bottom number and add them together, and if we get our top number, our answer was correct.
You can't take one ten from the thousands column.

As a test, the observer can paraphrase a teacher statement into a question or series of questions by which a student can discover the information contained in the teacher statement. If it is not reasonable

to assume that the student can answer a question to arrive at the information in the original statement, then the statement is not scored as a declarative statement.

At this point, the trainees will score the same two tapes for question types as well as prompting questions and teacher declaratives.

THIRD TRAINING SESSION

In this session, we'll discuss student response--verbal and non-verbal, praise and encouragement, and criticism.

Student Response (Indicated by letters in "student response" row of line.)

Verbal--when the teacher asks a question to which the student must respond, and the response can be judged correct or incorrect, the observer will score the student response in one of three categories: Correct = C; Incorrect/partially correct = I; Doesn't know = K. If a student answers yes or no to a question, the response will be scored C (correct).

Example:

Do you know all the words? (yes or no)
Do you know how to use the number line? (yes or no)

Non-Verbal--often a teacher will ask or direct a student to work a problem, use manipulatives, etc. When possible to make a determination, the observer will score the student's action as described above. Most often, the observer will be able to determine how the student responded by the teacher's reaction.

Example:

OK, that's great. You worked that problem with all the right steps.
When you used the number line, you forgot to include the first unit.

Students may respond to a question by shaking their heads, nodding, or shrugging. Again, the observer will note the response in the proper category.

Praise and Encouragement (Indicated by check in "teacher response" row.)

"Praise and encouragement are statements which carry the value judgment of approval. To look directly at a boy or girl and nod your head while saying "um-hm" with the proper inflection is to communicate to the pupil that he is on the right track and the teacher would like him to produce more of the same." (Flanders, 1970, pg. 41) Verbal praise consists of verbally rewarding the student who has given the desired or the correct response. "Good," "Fine," "That's right," "Correct," are examples of verbal praise.

Observers will score all teacher statements which praise the student for work being done or completed, or which encourage the student to continue with what he is doing.

Inflection will be an important determinant when scoring encouragement. "OK" may mean "Right, go on, you're doing fine," or it may mean "Let's stop and see what you're doing because it's not right," or it may be a "filler phrase" which the teacher uses habitually and which has little to do with what the child is doing.

The observer will score encouragement only when he can reasonably assume that the statement does have the effect of encouraging the student to continue. (When in doubt about the intent or effect of a statement, the observer might translate, or paraphrase the phrase into what he believes the message is. If still not clearly encouragement, the statement will not be scored.)

Constructive Correction/Criticism (Indicated by + or - in T. response row.)

Teachers generally respond to student errors with constructive correction or criticism. Observers will score instances of each response.

Criticism occurs when the teacher statement or response includes an element of recrimination, or the implication that the student should have been doing something else. (Flanders, 1970) The teacher response is verbal and has the effect of discouraging the student from further ventures. Indicated on the sequence line in the T. response row by a - (minus).

On a continuum from severe criticism to constructive correction, our line is near the center--that is, there must be a clear element of recrimination in a statement before the observer scores a statement as criticism.

Here the trainees watch the same two tapes again and score for all the skills described so far.

FOURTH TRAINING SESSION

In this session, we'll cover six demonstration techniques teachers often use in tutoring sessions.

Drawing a Picture or Diagram of the Problem (Indicated by D in Demo Tech row of Sequence line.)

"One of the best methods for understanding the requirements of a verbal reasoning problem is to draw a picture or diagram that shows the problem situation. The value of this technique is that words and numbers which express abstract ideas are made pictorial and thus more comprehensible."

Estimating (Indicated by E in Demo Tech row of sequence line.)

"Much of the mathematics that we use in our daily lives involves estimation rather than computation of exact answers." For example, instead of computing 27 + 39 = 66, we might say to ourselves, "Twenty-seven can be rounded off to 30, and 39 is almost 40, so the answer will be approximately 70." "It is therefore important that pupils learn to round off numbers and estimate answers. Also, estimating helps the pupil determine if his computed answer makes sense."

Writing a Number Sentence (Indicated by S in Demo Tech row of Sequence line.)

"Another helpful technique for developing pupil's understanding of verbal problems is the use of the number sentence." Consider this problem:

> A teacher wanted to give a worksheet to each of the 28 students in his class, but he had only 19 worksheets. How many did he still need?

"The first step in helping the pupil is to ask diagnostic questions to determine whether he can read the problem and select the appropriate number operation. If he cannot select the number operation, then it is helpful to have him draw a diagram of the problem situation and also write a number sentence. For example, the pupil might be led to write the number sentence 19 + __ = 28, or 28 - 19 = ___."

"With more complicated verbal problems, a longer number sentence is needed." Consider this example:

> Bill bought 4 flash bulbs for his camera at a cost of 45 cents each. If he gave the clerk a $5.00 bill, how much change would he get back?

"The solution of this problem requires two steps. These steps can be illustrated by drawing a diagram or picture and also by writing one of these number sentences: 500 - (4x45) = ___, or (4x45) + ___ = 500."

"The first step of drawing a diagram or picture of a verbal problem helps the pupil decide what number operation to use. The next step, of writing a number sentence, is a desirable tutoring technique since it helps the pupil see the relationship between the quantities in the problem and the actual number operation to be performed on them. Also, the use of number sentences in solving verbal problems develops the pupils understanding of mathematics as a language that is used in quantitative situations."

"It should be noted that after you have helped the pupil to select the appropriate number operation and to write a number sentence, he may still have difficulty in applying this information correctly. If this is the case, you will need to tutor him on number operations, thus using the tutoring techniques for number operations that we have studied: diagnostic questions to identify weaknesses in understanding, and demonstration techniques."

For the next three demonstration techniques, we would like to find out about how much time is spent during the session using each technique. At the start of each instance of use, put the letter standing for the technique in the appropriate box on the sequence line in the Tmd Demo Tech row. For each successive 3 seconds that the technique is used, put a check in each box following the letter.

Expanded Notation (Indicated by X in Tmd Demo Tech row.)

"Several important ideas in number operations can be explained by the use of expanded notation. For example, if the pupil does not understand the concept of place value, you can illustrate it by using expanded notation:

Place Value Notation	Expanded Notation
43	40+3
543	500+40+3
1543	1,000+500+40+3
11543	10,000+1,000+500+40+3

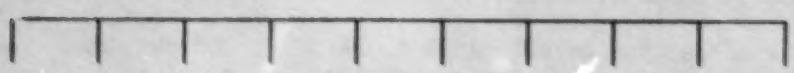
Expanded notation can also be used to develop understanding of regrouping.

726	700+20+6	(600+100)+20+6	600+120+6
-145	-100+40+5	100 +40+5	100+ 40+5
			500+ 80+1, or 581

Expanded notation makes regrouping more meaningful to the pupil than just being told to learn computational rules.

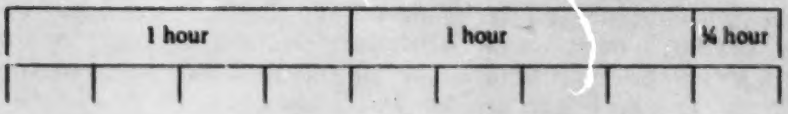
Figure 5. Examples of Diagrams Drawn for Verbal Reasoning Problems

1. A group of hikers plans to walk a trail 9 miles long. If they average 4 mph walking, how long will their hike take?

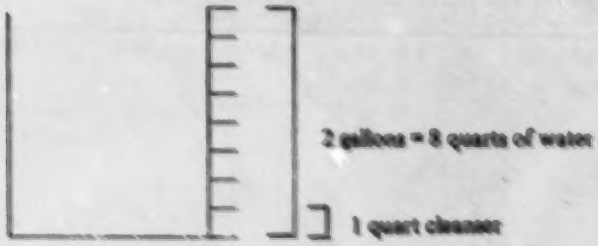


total distance = 9 miles

4 miles = 1 hour



2. The directions for a certain cleanser state that 1 quart of it should be mixed with 2 gallons of water. What is the ratio of cleanser to water?



1/8 = ratio of cleanser to water

The Number Line (Indicated by L on Tmd Demo Tech row)

"The number line is a versatile demonstration technique. It can be used to help pupils understand the continuum of number values, number operations, fractions, measurement, and other mathematical concepts and processes."

Manipulatives (Indicated by M in Tmd Demo Tech row.)

"One of the best demonstration techniques for tutoring pupils whose understanding of number operations is weak is to have them work with manipulatives (also called concrete materials).

At this point, trainees will watch Film Three of the Minicourse 5 series. And, after discussion will move on to Evaluation & Practice.

Evaluation

"After you have helped the pupil develop his understanding of a mathematical concept or process in the demonstration phase, you move to the evaluation phase. The purpose of evaluation is twofold; you want to determine how much the pupil has learned, and you want to know whether your tutoring was effective. To do this, you assign an example for the pupil to solve and observe his work. It is also helpful to ask the pupil to explain his problem-solving or computational procedure to you.

"The example you select for the evaluation phase should be similar to the one that originally gave the pupil trouble. There are several ways to obtain such an example. (1) You can make up a new example on your own. (2) You can select an example from the pupil's textbook or workbook. (3) If the pupil's difficulty was on a particular verbal reasoning problem, you can later use it for the evaluation phase. For example:

Original problem that pupil could not solve.
Tom has 48 cents. He wants to buy a ball that costs $2.50. How much more money does he need?

Revised problem for evaluation.
Tom has $5.36. He wants to buy a model airplane that costs $15.00. How much more money does he need?

"If you use this third method, be sure to have the pupil explain his problem-solving procedure to you. This technique prevents him from solving the revised problem by relying on rote recall of your demonstration of the original problem."

"An important feature of the evaluation phase is that the pupil must solve the example without your assistance. Occasionally, however, he may make an error. In that case, though you should minimize your assistance, you may prompt him by asking questions such as "Are you sure that's correct?" or "You've made a mistake here; can you find it?" If you need to prompt more than two or three times, however, it may be necessary to recycle."

"If the pupil experiences too much difficulty on the evaluation example, then recycle through the whole basic tutoring sequence. Recycling thus involves further diagnostic questioning, further use of demonstration techniques, and assignment of another evaluation example.

Practice

"If the pupil is able to solve the evaluation example correctly and understands the underlying process, then you should proceed to the last step of the basic tutoring sequence--practice. This step is simple but highly important. You assign examples similar to the one for which the pupil sought help so that he can consolidate his learning."

"In assigning additional examples for a pupil to solve, you should be aware of individual differences and needs. Some pupils may require only a few examples to consolidate and maintain the skills acquired in the tutoring session, but others may need to work many examples over a period of days or weeks."

"The practice examples you assign can be worked in the classroom without your assistance, or you can assign them as homework."

The observer will indicate whether practice problems have been assigned by circling Yes on the Form if they have, and No if they have not.

Number Operations or Verbal Reasoning

In the tutoring sessions you observe, students will be working on either verbal reasoning problems--"thought" or "word" problems--or number operations. On the top of the sequence line, you will indicate which type the student is working by circling VR if the student is working on a verbal reasoning problem, and NO if a number operations problem.

A strategy for each problem type is outlined below. The outline will give the observer an idea as to what question types or demonstration techniques might occur given the problem type--but it is quite likely that any of the techniques or question types could occur with either problem type.

Number Operations

Diagnosis
- Ask general questions
- Ask questions to test the pupil's understanding of place value, regrouping, renaming, and other number concepts.

Demonstration
- Have the pupil estimate an answer
- Use expanded notation
- Use the number line
- Use manipulatives

Evaluation
- Assign an example for purposes of evaluation

Practice
- Assign examples for practice

Verbal Reasoning Problems

Diagnosis
- Ask general diagnostic questions
- Ask the pupil to read the problem
- Ask if there are words he doesn't understand
- Ask the pupil to decide what number operation to use

Demonstration
- Have the pupil estimate an answer
- Have the pupil draw a diagram or picture of the problem
- Have the pupil write a number sentence

Evaluation
- Assign an example for purposes of evaluation

Practice
- Assign examples for practice

Trainees will view Film Four of the Minicourse 5 series. This film covers evaluation and practice.

After any discussion, trainees will again score the two training tapes for all behaviors covered so far.

Rapport/Warmth

We are interested in getting some measure or the rapport or warmth between teacher and student during a tutoring session. This is admittedly a subjective area--with many "depends on" to affect an estimation--teacher, student, and observer personality and style among the more obvious.

We can suggest some guidelines however. The observer should be aware of some of the following indicators throughout the session:

-the child's willingness to respond and volunteer
-the teacher's effort to understand the child's responses both correct and incorrect.
-the quality of encouragement offered--habitual phrases or genuine enthusiasm
-tense or relaxed situation
-any humor, smiling or laughing by either the child or the teacher

Our measure is a scale from 1 to .9. One is minimal rapport with little communication, no warmth, probably tension. Five is a neutral situation. Nine is extremely warm with very good rapport, teacher empathy and involvement.

Motivating Statement

A statement made by the teacher near the end of the tutoring session which has the effect of encouraging the student. It may consist of praise for the work done in the session just over, and anticipate progress and success in coming sessions.

Examples:

You made a lot of progress today. Do a great job on those problems and then we'll know that you understand decimals.

You are doing just great with that long division. Keep up the good work!

The observer will indicate whether the teacher has given a motivating statement by circling Yes on the back of the observer form in the Motivating Statement line if the teacher has, and No if the teacher has not.

MATH TUTORING STUDY

Study II: Paraprofessionals as Tutors

Effective Teacher Education Program

Appendices to Final Report

Williams, Barbara I.
Banks, Henry A.
Berliner, David C.
Cahen, Leonard S.
Ward, Beatrice A.

With special advice and assistance from

Linn, Robert L.
Dunbar, Charles R.

Far West Laboratory for Educational Research and Development, San Francisco, California

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APPENDIX A

Teacher Logs (tutor and classroom teachers)

Tutor Log

Tutor _____ School _____

Week of _____

Math area for class for week: _____

Student: _____

SESSION 1/Date:	SESSION 2/Date:
Class Activity: _____	Class Activity: _____
Problem: _____	Problem: _____
Comments: _____	Comments: _____
Progress? _____	Progress? _____
Time Spent: _____	Time Spent: _____

Student: _____

Class Activity: _____	Class Activity: _____
Problem: _____	Problem: _____
Comments: _____	Comments: _____
Progress? _____	Progress? _____
Time Spent: _____	Time Spent: _____

TEACHER LOG -- Control Teachers

Teacher _____

School _____ Grade _____

Week of _____

Indicate those pupils who receive <u>five minutes</u> or more of individual help from you.

Date	Name	Nature of Problem	Time Spent

Indicate the topic that was covered in the 30 minutes of additional mathematics instruction:

_____

APPENDIX B

Tests/Psychometrics

Grade 4 CTBS PRE

Item	Mean	Std. Dev.	Corre'
1	0.88	0.33	0.373
2.	0.89	0.32	0.318
3	0.83	0.37	0.347
4	0.75	0.44	0.391
5	0.85	0.36	0.288
6	0.81	0.39	0.336
7	0.62	0.49	0.341
8	0.64	0.49	0.447
9	0.72	0.45	0.511
10	0.61	0.49	0.520
11	0.75	0.44	0.548
12	0.64	0.48	0.513
13	0.63	0.48	0.591
14	0.67	0.47	0.552
15	0.57	0.50	0.580
16	0.33	0.47	0.585
17	0.55	0.50	0.605
18	0.51	0.50	0.633
19	0.44	0.50	0.372
20	0.41	0.49	0.598
21	0.43	0.50	0.655
22	0.35	0.48	0.610
23	0.52	0.50	0.709
24	0.28	0.45	0.465
25	0.41	0.49	0.625
26	0.30	0.46	0.622
27	0.30	0.46	0.670
28	0.22	0.41	0.519
29	0.27	0.45	0.616
30	0.17	0.38	0.602
31	0.25	0.43	0.636
32	0.25	0.44	0.576
33	0.15	0.36	0.402
34	0.10	0.30	0.340
35	0.25	0.44	0.658
36	0.09	0.29	0.248
37	0.15	0.36	0.442
38	0.23	0.42	0.477
39	0.16	0.37	0.463
40	0.20	0.40	0.577
41	0.11	0.32	0.267
42	0.13	0.3[illegible]	0.458
43	0.05	0.2[illegible]	0.195
44	0.13	0.34	0.362
45	0.09	0.29	0.311
46	0.06	0.24	0.310
47	0.10	0.30	0.279
48	0.09	0.28	0.183

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	162	18.90	9.76	2.55	0.031

Grade 4 CTBS POST

Item	Mean	Std. Dev.	Correl.
1	0.96	0.20	0.320
2	0.92	0.27	0.295
3	0.94	0.24	0.404
4	0.80	0.40	0.354
5	0.85	0.36	0.435
6	0.80	0.40	0.464
7	0.74	0.44	0.433
8	0.74	0.44	0.371
9	0.83	0.38	0.517
10	0.75	0.44	0.491
11	0.78	0.42	0.417
12	0.77	0.43	0.448
13	0.77	0.42	0.563
14	0.78	0.41	0.577
15	0.75	0.44	0.534
16	0.64	0.48	0.675
17	0.67	0.47	0.498
18	0.77	0.42	0.519
19	0.64	0.48	0.453
20	0.59	0.49	0.575
21	0.64	0.48	0.672
22	0.46	0.50	0.595
23	0.65	0.48	0.740
24	0.40	0.49	0.514
25	0.62	0.49	0.761
26	0.48	0.50	0.579
27	0.57	0.50	0.649
28	0.44	0.50	0.667
29	0.48	0.50	0.695
30	0.44	0.50	0.658
31	0.46	0.50	0.698
32	0.47	0.50	0.698
33	0.29	0.46	0.461
34	0.17	0.37	0.179
35	0.41	0.49	0.699
36	0.25	0.43	0.259
37	0.24	0.43	0.418
38	0.32	0.47	0.622
39	0.32	0.47	0.536
40	0.38	0.49	0.746
41	0.26	0.44	0.502
42	0.23	0.43	0.451
43	0.12	0.33	0.347
44	0.39	0.49	0.533
45	0.24	0.43	0.472
46	0.19	0.39	0.291
47	0.25	0.43	0.390
48	0.15	0.36	0.316

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	162	25.85	11.01	2.63	0.943

Grade 5 CTBS PRE

Item	Mean	Std. Dev.	Correl.
1	0.91	0.29	0.397
2	0.89	0.31	0.404
3	0.87	0.34	0.336
4	0.77	0.42	0.460
5	0.85	0.36	0.334
6	0.84	0.37	0.467
7	0.68	0.47	0.441
8	0.69	0.46	0.568
9	0.78	0.41	0.556
10	0.69	0.46	0.553
11	0.78	0.41	0.580
12	0.72	0.45	0.561
13	0.77	0.42	0.583
14	0.78	0.42	0.603
15	0.80	0.40	0.562
16	0.62	0.49	0.615
17	0.66	0.48	0.458
18	0.77	0.42	0.589
19	0.61	0.49	0.502
20	0.61	0.49	0.415
21	0.65	0.48	0.647
22	0.49	0.50	0.648
23	0.67	0.47	0.672
24	0.51	0.50	0.527
25	0.64	0.48	0.667
26	0.54	0.50	0.578
27	0.53	0.50	0.667
28	0.47	0.50	0.549
29	0.53	0.50	0.610
30	0.41	0.49	0.525
31	0.49	0.50	0.566
32	0.49	0.50	0.643
33	0.36	0.48	0.316
34	0.20	0.40	0.196
35	0.47	0.50	0.620
36	0.25	0.44	0.116
37	0.31	0.46	0.370
38	0.41	0.49	0.577
39	0.35	0.48	0.524
40	0.46	0.50	0.581
41	0.33	0.47	0.521
42	0.22	0.42	0.358
43	0.15	0.36	0.152
44	0.26	0.44	0.403
45	0.29	0.46	0.573
46	0.18	0.39	0.234
47	0.27	0.45	0.339
48	0.25	0.44	0.267

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	158	26.27	10.70	2.74	0.935

Grade 5 CTBS POST

Item	Mean	Std. Dev.	Corrl.
1	0.92	0.27	0.[illegible]90
2	0.89	0.32	0.[illegible]90
3	0.90	0.30	0.[illegible]80
4	0.77	0.42	0.[illegible]37
5	0.86	0.35	0.[illegible]86
6	0.77	0.42	0.[illegible]12
7	0.68	0.47	0.[illegible]76
8	0.65	0.48	0.[illegible]72
9	0.81	0.39	0.[illegible]81
10	0.77	0.42	0.[illegible]42
11	0.78	0.42	0.581
12	0.71	0.46	0.597
13	0.82	0.39	0.552
14	0.84	0.37	0.593
15	0.70	0.46	0.635
16	0.71	0.46	0.629
17	0.67	0.47	0.[illegible]84
18	0.70	0.46	0.60[illegible]
19	0.60	0.49	0.458
20	0.59	0.49	0.550
21	0.57	0.50	0.726
22	0.46	0.50	0.652
23	0.65	0.48	0.675
24	0.52	0.50	0.414
25	0.56	0.50	0.729
26	0.56	0.50	0.581
27	0.61	0.49	0.513
28	0.60	0.49	0.545
29	0.58	0.50	0.507
30	0.54	0.50	0.614
31	0.60	0.49	0.636
32	0.58	0.50	0.491
33	0.45	0.50	0.353
34	0.28	0.45	0.312
35	0.53	0.50	0.607
36	0.40	0.49	0.336
37	0.40	0.49	0.360
38	0.53	0.50	0.554
39	0.51	0.50	0.525
40	0.51	0.50	0.577
41	0.42	0.50	0.386
42	0.30	0.46	0.295
43	0.20	0.40	0.262
44	0.49	0.50	0.487
45	0.30	0.46	0.461
46	0.23	0.42	0.304
47	0.36	0.48	0.519
48	0.29	0.46	0.293

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	158	28.13	11.36	2.75	0.941

Grade 4 ITBS PRE

Item	Mean	Std. Dev.	Correl.
1	0.67	0.47	0.234
2	0.66	0.50	0.055
3	0.70	0.46	0.206
4	0.60	0.60	0.381
5	0.65	0.48	0.432
6	0.54	0.50	0.438
7	0.67	0.47	0.528
8	0.56	0.50	0.448
9	0.35	0.48	0.551
10	0.48	0.50	0.526
11	0.36	0.48	0.498
12	0.40	0.50	0.426
13	0.52	0.50	0.569
14	0.38	0.49	0.474
15	0.43	0.50	0.613
16	0.48	0.50	0.511
17	0.20	0.40	0.463
18	0.31	0.46	0.498
19	0.24	0.43	0.370
20	0.30	0.46	0.385
21	0.12	0.33	0.268
22	0.22	0.42	0.494
23	0.31	0.46	0.575
24	0.27	0.44	0.404
25	0.17	0.38	0.410
26	0.35	0.48	0.544
27	0.31	0.47	0.644
28	0.20	0.40	0.566
29	0.23	0.42	0.495
30	0.36	0.48	0.643
31	0.17	0.38	0.618
32	0.16	0.37	0.292
33	0.24	0.43	0.346
34	0.24	0.43	0.413
35	0.16	0.37	0.443
36	0.15	0.36	0.289

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	162	12.96	7.32	2.46	0.887

Grade 4 ITBS POST

Item	Mean	Std. Dev.	Correl.
1	0.52	0.50	0.381
2	0.70	0.46	0.395
3	0.75	0.44	0.482
4	0.52	0.50	0.468
5	0.69	0.46	0.486
6	0.69	0.47	0.555
7	0.74	0.44	0.496
8	0.65	0.48	0.507
9	0.44	0.50	0.470
10	0.66	0.48	0.39[illegible]
11	0.34	0.48	0.564
12	0.48	0.50	0.403
13	0.62	0.49	0.555
14	0.36	0.48	0.543
15	0.57	0.50	0.614
16	0.66	0.48	0.614
17	0.27	0.44	0.442
18	0.53	0.50	0.588
19	0.36	0.48	0.368
20	0.34	0.48	0.363
21	0.26	0.44	0.506
22	0.44	0.50	0.533
23	0.56	0.50	0.586
24	0.49	0.50	.539
25	0.50	0.50	0.438
26	0.50	0.50	0.624
27	0.49	0.50	0.632
28	0.38	0.49	0.430
29	0.33	0.47	0.593
30	0.55	0.50	0.610
31	0.35	0.48	0.618
32	0.22	0.42	0.334
33	0.40	0.49	0.432
34	0.33	0.47	0.524
35	0.27	0.44	0.550
36	0.21	0.41	0.356

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	162	16.99	8.61	2.50	0.915

Grade 5 ITBS PRE

Item	Mean	Std. Dev.	Correl.
1	0.63	0.49	0.405
2	0.27	0.45	0.342
3	0.55	0.50	0.614
4	0.27	0.44	0.470
5	0.34	0.47	0.345
6	0.23	0.42	0.347
7	0.36	0.48	0.376
8	0.50	0.50	0.499
9	0.51	0.50	0.509
10	0.30	0.46	0.395
11	0.54	0.50	0.528
12	0.49	0.50	0.555
13	0.44	0.50	0.427
14	0.30	0.46	0.391
15	0.54	0.50	0.632
16	0.34	0.48	0.565
17	0.30	0.46	0.215
18	0.48	0.50	0.408
19	0.31	0.46	0.408
20	0.35	0.48	0.425
21	0.25	0.43	0.160
22	0.32	0.47	0.338
23	0.40	0.49	0.519
24	0.24	0.43	0.413
25	0.35	0.48	0.380
26	0.25	0.43	0.305
27	0.89	0.31	0.007
28	0.40	0.49	0.479
29	0.31	0.46	0.568
30	0.35	0.48	0.502
31	0.20	0.40	0.428
32	0.17	0.38	0.246
33	0.24	0.43	0.358
34	0.35	0.48	0.227
35	0.16	0.37	0.205
36	0.31	0.46	0.176
37	0.16	0.37	0.378
38	0.20	0.40	0.350
39	0.18	0.39	0.141
40	0.15	0.35	0.063
41	0.09	0.29	0.195
42	0.17	0.38	0.215

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	158	13.27	7.10	2.72	0.853

Grade 5 ITBS POST

Item	Mean	Std.Dev.	Correl.
1	0.70	0.46	0.343
2	0.37	0.49	0.396
3	0.61	0.49	0.312
4	0.45	0.50	0.200
5	0.31	0.46	0.452
6	0.30	0.46	0.358
7	0.57	0.50	0.493
8	0.76	0.43	0.487
9	0.60	0.49	0.487
10	0.33	0.47	0.479
11	0.64	0.48	0.502
12	0.62	0.49	0.522
13	0.46	0.50	0.536
14	0.28	0.45	0.446
15	0.62	0.49	0.500
16	0.54	0.50	0.523
17	0.34	0.47	0.098
18	0.59	0.49	0.397
19	0.38	0.49	0.558
20	0.49	0.50	0.578
21	0.30	0.46	0.374
22	0.42	0.50	0.596
23	0.51	0.50	0.569
24	0.30	0.46	0.468
25	0.40	0.49	0.475
26	0.29	0.46	0.250
27	0.25	0.43	0.270
28	0.49	0.50	0.534
29	0.37	0.48	0.547
30	0.40	0.49	0.468
31	0.22	0.41	0.363
32	0.27	0.44	0.131
33	0.41	0.49	0.413
34	0.41	0.49	0.235
35	0.27	0.44	0.162
36	0.31	0.46	0.412
37	0.30	0.46	0.462
38	0.32	0.47	0.273
39	0.22	0.42	0.314
40	0.23	0.42	0.172
41	0.19	0.39	0.226
42	0.25	0.44	0.184

TOTAL	N	Mean	Std.Dev.	Std. Erro	Meas.	Alpha
SCALE	158	17.09	7.80	2.84		0.868

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Grade 4 Attitude Towards Math PRE

Item	Mean	Std. Dev.	Correl.
1	2.08	0.93	0.491
2	1.89	1.03	0.356
3	2.27	0.93	0.394
4	1.76	0.94	0.479
5	2.90	0.99	0.301
6	2.07	1.03	0.466
7	2.13	1.08	0.657
8	2.30	1.10	0.235
9	2.04	1.06	0.562
10	2.16	0.99	0.558
11	2.29	1.04	0.490
12	2.10	0.90	0.413
13	1.99	0.96	0.479
14	2.04	1.03	0.258
15	2.15	0.87	0.550
16	2.16	0.82	0.439
17	2.01	0.96	0.401
18	2.28	0.98	0.582
19	2.01	0.82	0.225
20	1.57	0.88	0.390
21	1.59	0.95	0.440
22	2.15	1.00	0.449
23	2.29	0.97	0.470
24	2.25	1.02	0.265

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	161	50.47	10.05	4.39	0.809

Grade 4 Attitude Towards Math POST

Item	Mean	Std. Dev.	Correl.
1	2.23	0.90	0.530
2	1.90	1.02	0.427
3	2.38	1.01	0.468
4	1.78	0.92	0.492
5	2.69	1.03	0.428
6	2.14	0.94	0.548
7	2.09	1.04	0.690
8	1.92	1.01	0.259
9	2.07	1.05	0.670
10	1.97	0.83	0.416
11	2.44	1.04	0.622
12	1.96	0.83	0.582
13	2.01	0.97	0.512
14	1.90	0.97	0.348
15	2.20	0.90	0.438
16	2.24	0.83	0.392
17	1.87	0.93	0.378
18	2.14	0.88	0.606
19	2.13	0.95	0.381
20	1.58	0.92	0.387
21	1.56	0.91	0.614
22	2.19	0.97	0.469
23	2.07	0.91	0.520
24	2.32	1.06	0.432

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	160	49.79	11.05	4.18	0.857

Grade 5 Attitude Towards Math PRE

Item	Mean	Std. Dev.	Correl.
1	2.04	0.84	0.498
2	1.99	1.00	0.373
3	2.12	0.93	0.488
4	1.74	0.91	0.529
5	2.66	1.09	0.312
6	2.08	0.89	0.345
7	1.95	0.99	0.624
8	2.07	1.03	0.183
9	1.93	1.01	0.631
10	2.06	0.87	0.573
11	2.42	0.97	0.564
12	2.01	0.83	0.520
13	1.75	0.94	0.380
14	1.76	0.90	0.449
15	2.22	0.85	0.386
16	2.25	0.82	0.372
17	1.80	0.85	0.487
18	2.24	0.95	0.651
19	2.04	0.89	0.440
20	1.42	0.77	0.411
21	1.56	0.94	0.528
22	2.11	0.97	0.582
23	2.12	0.98	0.423
24	1.98	0.98	0.414

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	157	48.32	10.31	4.11	0.841

Grade 5 Attitude Towards Math POST

Item	Mean	Std. Dev.	Correl.
1	2.10	0.84	0.354
2	1.82	0.95	0.416
3	2.15	0.90	0.490
4	1.71	0.82	0.399
5	2.66	1.00	0.292
6	2.12	0.82	0.301
7	2.02	0.97	0.567
8	1.99	1.14	0.181
9	2.18	0.99	0.565
10	1.95	0.77	0.579
11	2.42	0.91	0.539
12	2.00	0.87	0.624
13	1.87	0.91	0.614
14	1.70	0.99	0.472
15	2.24	0.85	0.318
16	2.23	0.84	0.425
17	1.75	0.84	0.558
18	2.10	0.87	0.548
19	1.87	0.83	0.269
20	1.45	0.81	0.526
21	1.42	0.81	0.618
22	2.21	1.00	0.548
23	2.18	0.97	0.614
24	1.95	0.95	0.397

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	154	48.08	10.07	4.02	0.841

Grade 4 External Locus of Control PRE

Item	Mean	Std. Dev.	Correl.
1	3.11	0.96	0.481
2	2.82	0.79	0.419
3	2.49	1.01	0.542
4	3.00	0.85	0.489
5	2.63	1.12	0.630
6	3.16	1.02	0.556
7	3.07	0.95	0.533
8	2.42	0.95	0.464
9	3.47	0.91	0.441

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	161	26.16	4.37	2.62	0.642

Grade 4 External Locus of Control POST

Item	Mean	Std. Dev.	Correl.
1	3.30	0.85	0.544
2	2.99	0.87	0.492
3	2.83	1.04	0.409
4	2.99	0.87	0.546
5	2.82	1.08	0.866
6	3.29	0.87	0.538
7	3.24	0.94	0.382
8	2.54	0.94	0.382
9	3.59	0.83	0.381

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	160	27.59	4.29	2.52	0.655

Grade 5 External Locus of Control PRE

Item	Mean	Std. Dev.	Correl.
1	3.31	0.97	0.694
2	2.83	0.88	0.432
3	2.61	1.11	0.629
4	3.06	0.88	0.546
5	2.81	1.12	0.527
6	3.27	0.83	0.508
7	3.23	0.99	0.665
8	2.44	0.94	0.464
9	3.43	0.95	0.614

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	156	26.99	4.92	2.54	0.734

Grade 5 External Locus of Control POST

Item	Mean	Std. Dev.	Correl.
1	3.39	0.86	0.609
2	2.89	0.87	0.350
3	3.06	1.12	0.606
4	3.23	0.78	0.632
5	3.12	1.02	0.558
6	3.28	0.90	0.599
7	3.27	0.89	0.570
8	2.55	0.95	0.475
9	3.68	0.69	0.435

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	154	28.47	4.37	2.43	0.690

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Grade 4 Academic Self-Concept PRE

Item	Mean	Std. Dev.	Correl.
1	2.98	1.29	0.532
2	3.01	1.32	0.392
3	3.23	1.39	0.443
4	3.62	1.33	0.487
5	3.31	1.34	0.451
6	2.96	1.26	0.558
7	3.51	1.25	0.465
8	3.56	1.26	0.513
9	2.92	1.24	0.368
10	3.34	1.42	0.578
11	3.27	1.49	0.449
12	3.36	1.38	0.392
13	3.41	1.32	0.588
14	3.22	1.49	0.343
15	3.41	1.21	0.544
16	3.21	1.30	0.623
17	3.47	1.40	0.480
18	3.25	1.53	0.478
19	3.84	1.21	0.627
20	3.56	1.27	0.506
21	3.72	1.35	0.589
22	3.66	1.34	0.618
23	3.69	1.27	0.406
24	3.39	1.32	0.502
25	3.61	1.26	0.417
26	3.49	1.27	0.561
27	3.57	1.32	0.397
28	4.00	1.30	0.367

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	161	95.58	18.09	6.25	0.881

Grade 4 Academic Self-Concept POST

Item	Mean	Std. Dev.	Correl.
1	3.04	1.23	0.684
2	3.21	1.30	0.568
3	3.37	1.37	0.530
4	3.88	1.19	0.513
5	3.24	1.29	0.587
6	2.87	1.27	0.622
7	3.64	1.24	0.590
8	3.59	1.34	0.495
9	3.04	1.27	0.574
10	3.31	1.30	0.636
11	3.33	1.46	0.503
12	3.26	1.30	0.613
13	3.47	1.31	0.514
14	3.14	1.48	0.454
15	3.51	1.21	0.713
16	3.18	1.25	0.581
17	3.27	1.41	0.544
18	2.99	1.44	0.454
19	3.73	1.27	0.621
20	3.30	1.31	0.513
21	3.50	1.28	0.532
22	3.45	1.36	0.713
23	3.53	1.28	0.550
24	3.28	1.31	0.650
25	3.38	1.38	0.539
26	3.49	1.23	0.703
27	3.51	1.40	0.554
28	3.90	1.35	0.341

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	157	94.38	20.84	5.87	0.921

Grade 5 Academic Self-Concept PRE

Item	Mean	Std. Dev.	Correl.
1	3.23	1.23	0.625
2	3.09	1.21	0.466
3	3.25	1.44	0.444
4	3.73	1.29	0.622
5	3.40	1.19	0.604
6	2.88	1.21	0.536
7	3.60	1.20	0.378
8	3.78	1.21	0.511
9	2.93	1.28	0.547
10	3.48	1.26	0.602
11	3.18	1.54	0.359
12	3.22	1.35	0.568
13	3.46	1.31	0.601
14	3.44	1.47	0.468
15	3.51	1.10	0.608
16	3.28	1.29	0.611
17	3.54	1.22	0.554
18	2.82	1.47	0.522
19	3.64	1.34	0.519
20	3.62	1.38	0.573
21	3.49	1.38	0.588
22	3.69	1.25	0.603
23	3.64	1.18	0.512
24	3.47	1.26	0.559
25	3.40	1.29	0.596
26	3.44	1.33	0.508
27	3.71	1.31	0.500
28	3.91	1.34	0.411

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	156	95.83	19.37	5.94	0.906

Grade 5 Academic Self-Concept POST

Item	Mean	Std. Dev.	Correl.
1	3.26	1.18	0.624
2	3.13	1.29	0.620
3	3.47	1.41	0.590
4	3.70	1.36	0.583
5	3.59	1.10	0.627
6	3.08	1.23	0.598
7	3.75	1.21	0.577
8	3.71	1.25	0.692
9	2.90	1.21	0.618
10	3.53	1.28	0.693
11	3.03	1.53	0.567
12	3.36	1.34	0.639
13	3.67	1.19	0.715
14	3.37	1.51	0.449
15	3.59	1.05	0.672
16	3.29	1.20	0.723
17	3.47	1.32	0.675
18	2.89	1.42	0.552
19	3.67	1.32	0.721
20	3.73	1.17	0.590
21	3.50	1.38	0.641
22	3.73	1.23	0.726
23	3.72	1.17	0.640
24	3.56	1.21	0.599
25	3.49	1.37	0.650
26	3.52	1.19	0.642
27	3.54	1.38	0.546
28	3.80	1.40	0.265

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	157	97.05	21.97	5.50	0.937

Grade 4 Math Self-Concept PRE

Item	Mean	Std. Dev.	Correl.
1	3.05	1.33	0.537
2	2.86	1.37	0.678
3	2.99	1.40	0.692
4	3.04	1.35	0.541
5	2.90	1.48	0.511
6	3.77	1.30	0.556
7	3.15	1.46	0.673
8	2.90	1.40	0.634

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	161	24.65	6.69	3.35	0.750

Grade 4 Math Self-Concept POST

Item	Mean	Std. Dev.	Correl.
1	3.10	1.27	0.593
2	3.17	1.34	0.686
3	3.52	1.38	0.650
4	3.31	1.32	0.636
5	2.94	1.38	0.673
6	3.82	1.23	0.576
7	3.63	1.34	0.669
8	3.47	1.34	0.608

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	157	26.96	6.76	3.09	0.791

Grade 5 Math Self-Concept PRE

Item	Mean	Std. Dev.	Correl.
1	3.06	1.22	0.542
2	3.09	1.36	0.659
3	3.36	1.42	0.694
4	3.35	1.35	0.526
5	2.83	1.34	0.519
6	3.74	1.31	0.649
7	3.51	1.43	0.714
8	3.07	1.33	0.619

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	156	26.01	6.64	3.20	0.767

Grade 5 Math Self-Concept POST

Item	Mean	Std. Dev.	Correl.
1	3.27	1.24	0.639
2	3.22	1.29	0.597
3	3.63	1.31	0.757
4	3.27	1.32	0.674
5	2.99	1.28	0.640
6	4.00	1.24	0.726
7	3.89	1.36	0.763
8	3.70	1.28	0.722

TOTAL	N	Mean	Std. Dev.	Std. Error Meas.	Alpha
SCALE	157	27.97	7.13	2.83	0.843

APPENDIX C

Description of Minicourse 5:

Individualizing Mathematics Instruction

Minicourse 5: Individualizing Instruction in Mathematics

The training of teachers assigned to the Minicourse 5 trained tutor treatment was accomplished through the use of Minicourse 5: Individualizing Instruction in Mathematics. The training schedule is described on pages ; in this appendix, the teaching skills and Minicourse instructional procedures are described.

Minicourse 5 is one of a series of teacher training programs developed and tested by the Far West Laboratory for Educational Research and Development. Originally published in 1971, it employs an instructional strategy in which teachers study the skills to be acquired, practice them with their own students, and evaluate their own progress in skill acquisition.

The skill practice component of the training cycle utilizes microteaching -- so called because the teacher applies the skills he is acquiring in a simpler setting than that of the customary classroom environment. In Minicourse 5, microteaching is conducted in a quiet room outside of the classroom where the teacher may devote his attention to the tutoring skills he is practicing. Microteach lessons are videotaped so that the teacher may subsequently play the tape and evaluate his use of the teaching skills with the assistance of self-evaluation forms contained in the course materials.

In a typical Minicourse lesson, the teacher:

1. Reads a chapter of the Teacher Handbook for the course to learn about the teaching skills emphasized in a given lesson.

2. Views an instructional film in which the teaching skills for the lesson are demonstrated in actual lessons.

3. Plans and conducts a microteach lesson in which he seeks to apply the teaching skills he has studied and seen demonstrated.

4. Evaluates his own performance while replaying a videotape of the microteach lesson he has conducted.

5. Reteaches and reevaluates the lesson (with another on the same pupil) to refine his use of the teaching skills.

While these steps may be modified somewhat for specific Minicourse lessons, they reflect the fundamental instructional strategy utilized in Minicourse 5.

The lesson objectives and teaching skills for Minicourse 5 are reproduced below as they appear in the Teacher Handbook used in training teachers for this study.

LESSON 1

Objective: To improve teacher skill in rewarding pupils' correct responses and encouraging their active participation in the tutoring process.

Skills: Using verbal praise to reward correct responses.

Asking prompting questions to increase pupils' active involvement in the tutoring process.

LESSON 2

Objective: To increase teacher skill in diagnosing pupils' deficiencies in understanding mathematical concepts and computational procedures.

Skills: Asking general diagnostic questions (e.g., "How did you get your answer?").

Number operations: asking questions to test pupils' understanding of place value, regrouping, and other number concepts.

Verbal problems: asking questions to test pupils' ability to read the problem and to decide on an appropriate number operation.

LESSON 3

Objective: To increase teacher use of techniques that help to develop pupils' understanding of mathematical concepts and computational procedures.

Skills: Estimating an answer before using a computational algorithm.

Number operations: depending on the situation, using expanded notation, the number line, or manipulative materials.

Verbal problems: having the pupil draw a picture of the problem and write a number sentence to express the problems requirements.

LESSON 4

Objective: To increase teacher skill in evaluating pupil progress and assigning practice examples.

Skills: Assigning an evaluation example.

Assigning practice examples.

LESSON 5

Objective: To improve teacher skill in organizing the mathematics class period for individual tutoring.

Skills: Having pupils correct their own work.

Having pupils tutor each other (peer tutoring).

Appendix D

Analysis of Variance Summary Tales for Pre Measures

Table D-1

California Tests of Basic Skills PRE

Grade 4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	256.4	128.2	1.40	0.25
Within Groups	157	14356.6	91.4		
Total	159	14613.0			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	47	17.2	8.0	1.2	14.9 to 19.5
Math Only	37	19.5	10.1	1.7	16.2 to 22.9
Control	76	20.1	10.2	1.2	17.8 to 22.5
Total	160	19.1	9.6	0.8	17.6 to 20.6

Tests for Homogeneity of Variances

Cochrans C = 0.3871, P = 0.314 (Approx.)

Table D-2

California Tests of Basic Skills PRE

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	170.3	85.1	0.74	0.48
Within Groups	155	17809.1	114.9		
Total	157	17979.4			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	46	24.8	10.2	1.5	21.8 to 27.8
Math Only	44	26.2	11.9	1.8	22.6 to 29.9
Control	68	27.3	10.2	1.2	24.8 to 29.8
Total	158	26.3	10.7	0.9	24.6 to 28.0

Tests for Homogeneity of Variances

Cochrans C = 0.4057, P = 0.181 (Approx.)

Table D-3

Iowa Tests of Basic Skills

Grade 4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	82.4	41.2	0.80	0.46
Within Groups	156	8031.7	51.5		
Total	158	8114.2			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	48	12.1	7.0	1.0	10.1 to 14.2
Math Only	36	13.9	7.5	1.2	11.3 to 16.4
Control	75	13.6	7.1	0.8	11.9 to 15.2
Total	159	13.2	7.2	0.6	12.1 to 14.3

Tests for Homogeneity of Variances

Cochrans C = 0.3602, P = 0.601 (Approx.)

Table D-4

Iowa Tests of Basic Skills PRE

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	30.9	15.5	0.32	0.68
Within Groups	152	7349.4	48.4		
Total	154	7380.3			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	44	12.9	5.3	0.8	11.3 to 14.6
Math Only	44	14.1	8.3	1.3	11.6 to 16.6
Control	67	13.6	6.9	0.8	11.9 to 15.3
Total	155	13.6	6.9	0.6	12.5 to 14.7

Tests for Homogeneity of Variances

Cochrans C = 0.475, P = 0.012 (Approx.)

Table D-5

Attitude Toward Math PRE

Grade 4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	63.0	31.5	0.31	0.69
Within Groups	158	16101.2	101.9		
Total	160	16164.2			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	48	51.0	9.5	1.4	48.2 to 53.7
Math Only	37	51.2	11.3	1.9	47.4 to 54.9
Control	76	49.8	9.9	1.1	47.6 to 52.1
Total	161	50.5	10.1	0.8	48.9 to 52.0

Tests for Homogeneity of Variances

Cochrans C = 0.4065, P = 0.172 (Approx.)

Table D-6

Attitude Toward Math PRE

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	416.4	208.2	1.98	0.14
Within Groups	154	16173.3	105.0		
Total	156	16589.8			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	45	46.0	10.1	1.5	42.9 to 49.0
Math Only	44	50.2	10.6	1.6	47.0 to 53.4
Control	68	48.7	10.1	1.2	46.2 to 51.1
Total	157	48.3	10.3	0.8	46.7 to 49.9

Tests for Homogeneity of Variances

Cochrans C = 0.3557, P = 0.662 (Approx.)

Table D-8

Academic Self-Concept PRE

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	160.0	80.0	0.21	0.68
Within Groups	153	58021.0	379.2		
Total	155	58181.0			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	44	95.2	21.0	3.2	88.8 to 101.6
Math Only	44	94.7	18.8	2.8	89.0 to 100.4
Control	68	97.0	18.9	2.3	92.4 to 101.5
Total	156	98.8	19.4	1.6	92.8 to 98.9

Tests for Homogeneity of Variances

Cochrans C = 0.3824, P = 0.360 (Approx.)

Table D-9

Math Self-Concept PRE

Grade 4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	F Probability
Between Groups	2	37.8	18.9	0.42	0.65
Within Groups	158	7124.6	45.1		
Total	160	7162.3			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	49	25.1	6.1	0.9	23.3 to 26.8
Math Only	36	23.8	7.0	1.2	21.4 to 26.2
Control	76	24.8	7.0	0.8	23.2 to 26.4
Total	161	24.7	6.6	0.5	23.6 to 25.7

Tests for Homogeneity of Variances

Cochrans C = 0.3661, P = 0.524 (Approx.)

Table D-10

Math Self-Concept PRE

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	32.8	16.4	0.37	0.67
Within Groups	153	6803.3	44.5		
Total	155	6836.1			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	44	25.4	7.4	1.1	23.2 to 27.7
Math Only	44	25.8	7.0	1.1	23.6 to 28.0
Control	68	26.5	5.8	0.7	25.1 to 27.9
Total	156	20.0	6.6	0.5	25.0 to 27.1

Tests for Homogeneity of Variances

Cochrans C = 0.3972, P = 0.240 (Approx.)

Table D-11

Locus of Control PRE

Grade 4

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	7.5	3.8	0.19	0.67
Within Groups	158	3054.3	19.3		
Total	160	3061.8			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	48	25.9	4.4	0.6	24.6 to 27.2
Math Only	37	26.5	4.1	0.7	25.1 to 27.9
Control	76	26.2	4.5	0.5	25.1 to 27.2
Total	161	26.2	4.4	0.3	25.5 to 26.8

Tests for Homogeneity of Variances

Cochrans C = 0.3609, P = 0.589 (Approx.)

Table D-12

Locus of Control PRE

Grade 5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F ratio	F Probability
Between Groups	2	79.8	39.9	1.66	0.19
Within Groups	153	3675.9	24.0		
Total	155	3755.7			

Group	N	Mean	Standard Deviation	Standard Error	95% Confidence Interval for Mean
Mini 5	45	27.8	4.4	0.6	26.6 to 29.1
Math Only	43	25.9	5.9	0.9	24.1 to 27.8
Control	68	27.1	4.8	0.6	25.9 to 28.2
Total	156	27.0	4.9	0.4	26.2 to 27.8

Tests for Homogeneity of Variances

Cochrans C = 0.4689, P = 0.016 (Approx.)

Appendix E

Mathematics Inventory

MATH TRAINING FOR PARAPROFESSIONAL TUTORS

Math training for the paraprofessional tutors was conducted by a Math Resource Teacher from the San Francisco Unified School District along with a member of the Math Tutoring Research Team. The training was designed to insure that all tutors had knowledge of the concepts and skills that were being taught in the 4th and 5th grade classrooms. The topics which were covered are listed below:

1.	Sets, Numbers and Numerations	(2 sessions)
2.	Sentences and Problem Solving	(1 session)
3.	Measurements	(1 session)
4.	Operations and Properties	(1 session)
5.	Geometry	(1 session)
6.	Relations and Functions	(1 session)
7.	Probability, Statistics & Graphing	(1 session)

MATHEMATICS INVENTORY

Name _____

Date _____

INSTRUCTIONS:

This inventory consists of 38 problems pertaining to the math concepts and skills that are taught to 4th and 5th grade students. Each problem is followed by a blank space for recording your answer. The purpose of the inventory is to test your knowledge of these math skills and concepts. This information will be used to identify the areas in mathematics which are to be covered in the training session.

Please work all problems.

Thank you

1

12	42	37
+ 25	+ 36	+ 51

2

35	68	93
- 13	- 46	- 81

3 WRITE THIS AS A COMPACT NUMERAL:

2,000,000 + 700,000 + 5,000 + 8 = _____

4 WRITE THIS IN EXPANDED FORM:

7,105,620 = _____

5 COMPLETE: (42 + 8) + 35 = 42 + (_____ + 35)

THIS IS CALLED _____PROPERTY.

6 RING THE NUMERAL WITH 5 IN THE HUNDREDS PLACE:

105 552 256

7 USE < > OR = IN THE CORRECT ◯ :

2 ◯ 3	7 ◯ 7	16 ◯ 9
6 ◯ 5	12 ◯ 15	8 ◯ 7

8 ROUND OFF TO THE NEAREST HUNDRED.

769 _____

432 _____

9 PUT A LINE UNDER THE AMOUNT THAT IS MORE.

7 Million

3 Billion

291

10 ROUND OFF TO THE NEAREST THOUSAND.

19,912 _____

5,806 _____

12,076 _____

11 USE EXPONENTS

6^2

3^3

_____

_____

12 FACTORS

_____

_____

6 X 6 X 6

2 X 2 X 2 X 2

13 COMPLETE THE COUNTING IN BASE FIVE:

0 1 2 3 4 10 11 ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

14 ADD IN BASE FIVE:

42	23	143
+ 31	+ 24	+ 121

15 SUBTRACT IN BASE FIVE:

43	104	132
- 23	- 32	- 43

16

ROMAN NUMERAL	OUR NUMERAL	OUR NUMERAL	ROMAN NUMERAL
XXIII	_____	52	_____
XIX	_____	____	CCVII
XXVII	_____	509	_____

17 WRITE = OR ≠ IN THE BOXES:

6 ☐ 4 + 1

3 + 2 ☐ 6 + 2

4 + 4 ☐ 2 + 6

5 + 7 ☐ 6 + 6

5 + 8 ☐ 4 + 10

18 FIND THE SUMS:

$\frac{2}{4} + \frac{1}{4} =$

$\frac{4}{3} + \frac{1}{3} =$

292

19 $6 \overline{)59}$

20 $9 \overline{)873}$

21 $4 \overline{)1474}$

22
$$\begin{array}{r} 67 \\ \times\ 50 \\ \hline \end{array}$$

23 $40 \overline{)1076}$

24 Check using multiplication ←

25
$$\begin{array}{r} 7 \\ \times\ 6 \\ \hline \end{array} \qquad \begin{array}{r} 9 \\ \times\ 9 \\ \hline \end{array}$$

26
$$\begin{array}{r} 8 \\ \times\ 6 \\ \hline \end{array} \qquad \begin{array}{r} 9 \\ \times\ 8 \\ \hline \end{array}$$

27
$$\begin{array}{r} 7{,}509 \\ \times\ 8 \\ \hline \end{array}$$

28
$$\begin{array}{r} 870{,}293 \\ -\ 146{,}892 \\ \hline \end{array}$$

29 Round off to nearest 10

27 _____

82 _____

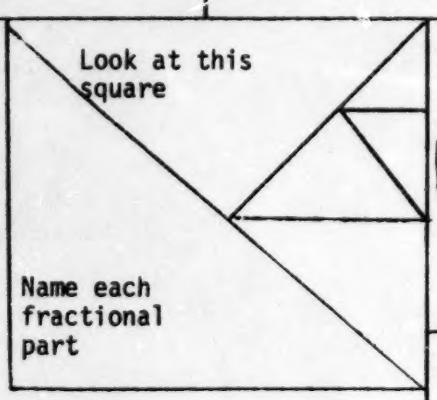
798 _____

30 Find the Product:

(7 X 8) X 3 = ____

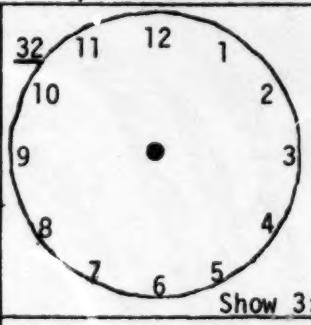
6 X (4 X 5) = ____

31 Look at this square



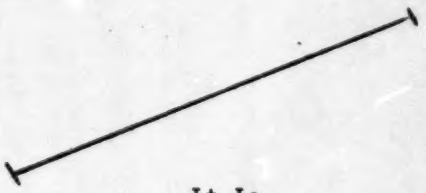
Name each fractional part

32



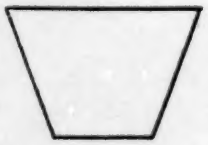
Show 3:52

33 Measure this line segment

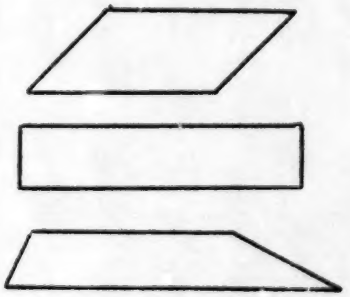


It Is _____

34 Draw 2 Diagonals



35 Match the name to one figure:



rectangle

parallelogram

quadrilateral

36

SET A = (2, 4, 6, 8)

SET B = (5, 7, 9,)

SET C = (2, 3, 4, 5, 6)

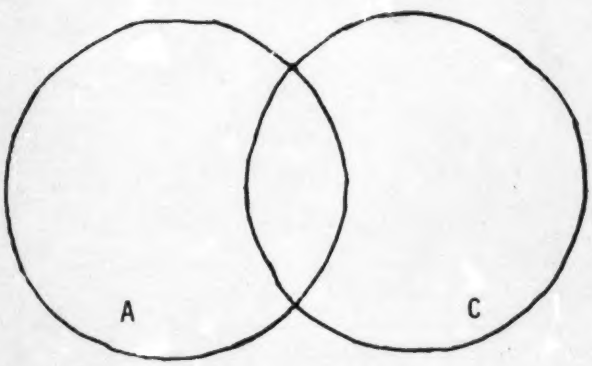
A $\cup$ C = _____ A $\cup$ B = _____

A $\cap$ C = _____ A $\cap$ B = _____

n(A) = _____ n(B) = _____ n(C)= _____

NAME A UNIVERSAL SET FOR SETS A, B, AND C. _____

COMPLETE THIS VENN DIAGRAM FOR SETS A AND C.



37

MEASUREMENT: WRITE THE EQUIVALENTS FOR

1. 2 feet = _____ inches
2. 1 meter = _____ centimeters
3. 1 yard = _____ feet or _____ inches
4. 1000 meters = 1 K_____
5. 7 feet = _____ yards and _____ feet
6. 40 inches = _____feet and _____ inches
7. 127 Cm = _____ m and 27 Cm

38

LIQUID MEASUREMENT:

8. 1 gallon = _____ quarts or _____ pints
9. 4 Cups = _____ ___ pints
10. 20 ounces = _____ cups and _____ ounces
11. $\frac{1}{2}$ Cup = _____ ounces